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GUEST EDITORIAL

A special issue on Fusarium head blight and wheat blast

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Fusarium head blight (FHB, or scab) of wheat and barley and wheat blast (or brusone) are two major head diseases with devastating impact on yield and grain quality. These fungal diseases emerged as a major threat to global food security and human health over three decades ago. Since the early 1990s, FHB, caused mainly by *Fusarium graminearum* sensu lato, resurged in wheat and barley crops worldwide, likely due to increased adoption of conservation tillage practices, expansion of maize production, and climate variability. The disease causes serious economic losses especially during wet seasons that favor epidemics and lead to mycotoxin accumulation at unacceptable levels in grain (McMullen et al. 2012). On the other hand, wheat blast caused by *Magnaporthe oryzae* Triticum pathotype (MoT, synonym *Pyricularia oryzae*), first discovered in northern Paraná State, Brazil, in 1985, had been restricted to South America, where sporadic outbreaks in the tropical, warmer, growing regions of Brazil and Bolivia have been reported (Maciel 2011). However, as anticipated by experts after devastating blast outbreaks in the 2000's, in March of 2016, the pathogen was found for the first time in Asia, in Bangladesh, where it suddenly devastated fields in 10 districts (Islam et al. 2016; Malaker et al. 2016). Infected fields were burned in an attempt to prevent inoculum survival, but blast reoccurred in Bangladesh in 2017. The potential for blast to spread and attack vulnerable wheat acreage in Asia is enormous. However, that was not the only important event for wheat pathologists in that year. Almost concomitantly to the discovery of the wheat blast in Bangladesh, members of the international research community had already planned to meet in Brazil to learn more about these two diseases.

We were pleased, around two years ago, to take the lead in organizing two important international conferences: the 5th International Symposium on Fusarium Head Blight (ISFHB) and the 2nd International Workshop on Wheat Blast (IWWB). For the first time offered as a joint meeting, the conferences were held at Costão do Santinho Resort, Florianópolis, Brazil, from 6 to 9 April 2016. The beautiful venue by the Praia do Santinho on the Florianopolis Island, certainly added to the success of the meeting. The participation in both conferences and the scientific contribution were overwhelming: 210 attendees from 38 countries (110 from Brazil, 141 abstracts, 20 keynote lectures, 24 invited talks and 97 poster presentations by researchers from all over the world (Fig. 1). A Book of Abstracts was organized and videos of some of the keynote presentations were recorded and are freely available (http://scabandblastofwheat2016.org).

The opportunity to prepare a special issue in the Brazilian Phytopathological Society's journal *Tropical Plant Pathology*, containing articles submitted by keynote and oral speakers of both conferences, could not be missed. We were very fortunate to have received eleven contributions (seven reviews, two original articles and two short communications), which were peer-reviewed and further accepted to compose this special issue containing five open access articles.

We open the issue with an article by the main plenary speaker of the 5th ISFHB. A short communication by Mallmann's Lab (Brazil) summarizes, to the best of our knowledge, the most comprehensive data (>16,000 HPLC analyses) on the prevalence and concentration of two

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Fig. 1 Group photo of the 5th International Symposium on Fusarium Head Blight and 2nd Workshop on Wheat Blast joint-meeting held at Costão do Santinho Resort, Florianóplis, Brazil, 6–9 April 2016

mycotoxins, deoxynivalenol (DON) and zearalenone, detected in commercial wheat and barley grain from southern Brazil during eight consecutive years. This adds a considerable amount of data for global knowledge on mycotoxin contamination in cereals and provides critical information to all sectors of the Brazilian wheat chain, given the promulgation of tolerated limits of these two mycotoxins in wheat grain and byproducts in 2011. Revisions of the limits have been proposed and productive discussions among several sectors have followed over the years. The availability of such data will surely aid further adjustments to the limits based on scientific criteria. This article is followed by Dr. Schwarz's (USA) review of the impacts of FHB and DON in malting and brewing processes, the solutions available to effectively prevent the problem and the challenging areas to be faced by multidisciplinary team of researchers and the industry parties, especially if the legislated limits becomes more strict and are expanded to other mycotoxins.

The next two articles are thorough reviews of talks given at two interrelated sessions: germplasm development and breeding for scab resistance and genetics and genomics of the resistance. For the first, Steiner and collaborators (Austria) present an overview of strategies and developments for selection of FHB-resistant lines, with an emphasis on morphological traits, and marker-assisted and genomic selection. According to the authors, progress has definitely been made but more effective and durable solutions will require further investment in breeding to incorporate resistance in regionally adapted and productive cultivars, as well as to avoid treating FHB resistance as an isolated trait. The second review by the Doohan Lab (Ireland) details the role of DON and genes that are activated during pathogenesis, mainly related with DON detoxification, such as *Fhb*1. Continuing efforts in this field can definitely provide useful markers for breeders, as well for the development of transgenic or gene-edited crops in the near future - say the authors.

In *Fusarium in the age of genomics*, Waalwijck and collaborators (The Netherlands) summarize a keynote talk at the Genetic and Genomics of *Fusarium* species session. The pros and cons of next generation sequence (NGS) platforms, the recent advances in genomic studies for *F. graminearum* and other *Fusaria*, and the potential to improve the understanding of the role of genetic elements (telomeres, centromeres and repetitive elements) from fully assembled genomes are discussed. Two contributions, selected among the posters presented within this session, provide new knowledge on species diversity, toxigenic potential and fungicide sensitivity of the pathogenic populations impacting the two major wheat and barley producers in South America. In Argentina, a major world wheat exporter, there is growing concern with the occurrence of mycotoxins at levels that impact trade. While the diversity of lineages within *F. graminearum* species complex (FGSC), which possess mainly the 15-ADON and NIV genotype, has been shown to be much higher in Brazil (Del Ponte et al. 2015) than in Argentina, 3-ADON genotypes (more potent DON producers) are more commonly found in the latter. However, factors shaping the distribution and temporal variations of the trichothecene genotypes are not entirely known and some hypotheses are made based on new data collected in Argentina during epidemic and non-epidemic

seasons. This raises concern should the climate continue to warm in the future. In southern Brazil, barley and wheat crops are managed similarly and the same pathogenic population affects both crops. Previous studies suggested that the frequency of NIV-producing FGSC members in barley is higher than in wheat in Brazil (Astolfi et al. 2011), but it was not known whether cultivars affect species composition. Additionally, the relatively low efficacy of fungicides was related to insensitivity in the populations from different lineages. The article by the Del Ponte Lab (Brazil) provides some answers for these two questions.

FHB is best managed when several methods are used in combination, but most farmers in areas at risk rely on fungicides applied once or twice around flowering to combat the disease and reduce mycotoxins. The performance and profitability of fungicides have been questioned and improved control would certainly benefit from novel tools capable of detecting inoculum and disease earlier. In this area, the last FHB article in this special issue is a contribution by Jon West (United Kingdom) who reviews most recent advances and potential of DNA-based technologies for FHB pathogen detection and remote sensing, reflectance and thermal imaging to map diseased fields and segregate harvested grain. The 'digital revolution', with its massive investments by the big industry players in data collection and analysis and automation, will certainly accelerate validation and adoption of these tools by farmers and optimize disease management.

The 2nd IWWB followed the 1st International workshop held at Passo Fundo, Brazil, in 2010 (http://blog.cimmyt.org/first-international-wheat-blast-meeting-held-in-brazil/) in response to the devastating wheat blast outbreak in Brazil in 2009. In the 2016 workshop, special guest Dr. Paritosh Kumar Malaker (Bangladesh) updated meeting participants on the still developing wheat blast outbreak in Bangladesh (https://www.youtube.com/watch?v=PwfDPuo6T-g). In this special issue, two reviews and an original article contribute to our current understanding and potential to improve wheat blast management and minimize losses by an intractable disease where the options for an effective control are limited.

The current global status of wheat blast and the recent advances in taxonomy, population biology, epidemiology and management via host resistance and fungicides is thoroughly reviewed by Valent and Cruz (USA). The recent findings by the Rodrigues Lab (Brazil) on the physiological changes and expression of genes associated with resistance to wheat blast is summarized, together with the group's findings on the effects of mineral nutrition and fungicides for managing wheat blast in Brazil, two promptly available options to integrated disease management.

Finally, the intensive plant disease modeling efforts conducted by Fernandes and collaborators (Brazil) over the years have resulted in the first wheat blast model that predicts inoculum build up, airborne spore concentration and weather favorability for infection to estimate a blast-risk day. The comparison of the model outputs with the historical data showed that high/low numbers of blast-risk days occurred during outbreak/non-outbreak years in northern Paraná. A web application was developed and is freely accessible over the web. The new knowledge and tools described in these three contributions will help to contain the damage from wheat blast disease.

The fact that scab and blast show easily confused wheat head symptoms (until close examination of infected heads shows the salmon pink color of the scab fungus or the gray color of the blast fungus), and both diseases are challenging to control suggested synergy in combining the 5th ISFHB and the 2nd IWWB. This proved to be the case. Continuing connection between these two scientific communities will contribute to advancing knowledge and containing these major threats to global wheat production and food security. Hope you enjoy the reading!

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