Wheat Yellow Rust

in the Extended Himalayan Regions and the Middle East

Editors Mingju Li & Sajid Ali

CHINA AGRICULTURE PRESS

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Foreword

Wheat (*Triticum aestivum* L.) is the most important food crop worldwide, which provides one-fifth of the protein and calories to more than 4.5 billion people. Yellow rust (also called stripe rust) caused by *Puccinia striiformis* f. sp. *tritici,* is one of the most destructive wheat diseases, which can result in significant yield losses or huge investment in chemical control. The extended Himalaya region (such as Nepal, Pakistan and China) is identified as a hotspot of sexual recombination and genetic diversity as well as the putative center of origin of the pathogen, while the Middle East is the origin center of common wheat along with the source of high-temperature adapted strain. These areas are critical for wheat yellow rust epidemic around the world. Therefore, it is crucial to know the details about wheat yellow rust situation and research progress in these hotspot regions. However, there was a lack of such a comprehensive book regarding wheat yellow rust focusing on these important regions. This was an incentive for us to write this book.

Compilation of information on yellow rust research in these regions is further important due to the potential invasions across these areas and to other parts of the world, as reported in recent past. There is a dire need for collaborative efforts at the regional and global level to anticipate and adopt preemptive measures to avoid such invasions. To initiate such a collaboration, it is highly important to provide a comprehensive background of various research work done in different countries. This provides another reason to compile such a book with contribution from experts from various countries of these regions.

This book, covers the countries such as China, Nepal, Pakistan, Iran, Iraq, and Egypt. Each country for one chapter, then the book includes 6 chapters, where each chapter addresses the research progress on different aspects of yellow rust. The chapters are arranged considering a rough order of the geographical position of the countries with a direction of east to west. The contents encompass disease epidemiology, host resistance, resistance gene utilization and resistance mechanisms, pathogen population genetic structure, pathogenicity mechanisms, effector proteome, integrate management, as well as future perspectives etc. Of courses, not all the countries had the same level of work in various areas of research and thus the chapters could not be coherent to this extent to give details about all the topics at the same level.

There are many publications on wheat yellow rust from these countries. We tried to summarize the information based on as many as we can but it impossible

to include all. We express our regret to those whose papers are missed in this book. We especially thank the scientists who made great contributions to the great body of knowledge on yellow rust. We do hope that this book will provide helpful information for interested researchers and prompt future cooperation among these countries to combat wheat yellow rust. Finally, we welcome any comments and criticisms to this book.

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November 10, 2021

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Contents

Chapter 1

Wheat yellow rust in China – current status and future perspectives

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Abstract: Yellow (stripe) rust, caused by *Puccinia striiformis* f. s*p. tritici*, is considered to be the current most important crop disease in China. Comprehensive research on yellow rust has been carried out among a nationwide network of colleagues working for more than six decades. This review summarized the current knowledge of the epidemiology of wheat yellow rust, including over-summering, over-wintering, inter-regional dispersal of inoculum, resistance gene characterization, utilization and resistance mechanisms, race monitoring and population genetics of the pathogen, pathogenicity mechanisms and effector proteome. The information would be useful to propose a sustainable control strategy in China which mainly base on the use of resistance cultivars, supplemented by ecological regulation and accurate chemicals control.

Keywords: Wheat yellow (stripe) rust; *Puccinia striiformis* f. sp*. tritici*; *Yr* gene; physiological race; China

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Acknowledgments

This work was supported by the National Natural Science Foundation of China (31560490), the National Key R&D Program of China (2018YFD0200500), as well as the Major special project of Yunnan Province (202102AE090003, 202102AE090014).

Chapter 2

Wheat yellow rust in Nepal

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Abstract: Agriculture is one of the important components of the economy of Nepal and thus the main contributor to the nation's food security, to which wheat plays an important role. Several obstacles are faced by the wheat crop, which challenge the genetic potential of wheat varieties, thus reducing the overall yield. Among these factors, wheat yellow rust disease, caused by *Puccinia striiformis* is highly important. Previous work has been done in Nepal to cover many aspects, from disease surveillance, field screening to race phenotyping and population genetics of the pathogen. For rust management, several activities had been adopted including development of resistant varieties, early maturing varieties, short duration grain filling varieties, heat tolerant varieties, application of fungicides along with different gene deployment at different locations. The current book chapter aims to describe the status, importance and future management of wheat yellow rust disease in Nepal. It will provide some basic information to devise a sustainable disease management and resistance gene deployment strategy.

Keywords: Wheat yellow rust; *Puccinia striiformis* f. sp. *tritici* (*Pst*); Disease resistance; Diseases management; Wheat cultivation; Nepal

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Chapter 3

Wheat yellow rust status across Pakistan – a part of the pathogen center of diversity

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Abstract: Wheat yellow rust is one of the important diseases of wheat worldwide, with presence of huge diversity in the Himalayan and near-Himalayan region, including Pakistan. The chapter attempts to provide a comprehensive summary of various research work done on yellow rust across Pakistan. Most of the earlier research work in Pakistan was mainly focused on field testing of candidate lines and released varieties across multiple locations along with trap nurseries to assess variability in the pathogen population based on infection on the differential lines with certain known genes. In the past two decades, intensive research work has been done using molecular markers-based screening of the host genotypes, both breeding lines and released varieties. Similarly, a strong research group has been established to track the pathogen population structure, using extensive surveillance and sequencing-based genotyping. The chapter summarize the knowledge of the disease epidemics, pathogen population structure, resistance gene in host germplasm and integrated management of rust in Pakistan. The information should be useful for future resistance gene

deployment and disease management, not only in Pakistan but also at regional and global scale.

Keywords: Wheat yellow rust; *Puccinia striiformis* f. s*p. tritici* (*Pst*); resistance; pathogenicity

Acknowledgement

The authors contributing to the chapter were supported by the funds received from the U.S. Department of Agriculture, Agricultural Research Service, under agreement No. 58-0206-0-171 F (Wheat Productivity Enhancement Program-WPEP) and Start-up Research Grant, Higher Education Commission, Pakistan.

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Chapter 4

Wheat yellow rust in Iran – status, challenges and perspectives

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Abstract: Wheat yellow (stripe) rust is the major disease of wheat in most part of Iran, during winter or early spring, especially at higher elevations. The causal pathogen on *Triticeae* is *Puccinia striiformis* revealed based on the molecular and morphological study of specimens collected from different hosts in Iran. This chapter describes the main agro-ecological traits of Iran, the economic importance of wheat yellow rust and historical epidemics. An effort is made to summarize the results of the work done on wheat yellow rust epidemiology, resistance gene in host and its mechanism, pathogen population biology, population genetics and physiological races identification. It concludes on the integration of this information for the management of wheat yellow rust resistance and future avenues to work in Iran.

Keywords: Wheat yellow rust; resistance; pathogenicity

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Chapter 5

Wheat yellow rust in Iraq – current status and future challenges

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Abstract: Wheat yellow (stripe) rust disease incited by the basidiomycetes fungus *Puccinia striiformis* f. sp. *tritici* (*Pst*) is currently considered as one of the most destructive foliar diseases of wheat in many wheat-growing areas in Iraq. Yield losses may reach to more than 60% on the susceptible wheat cultivars. During the last five decades' extensive scientific research was conducted on the disease by the national scientists. The current chapter summarizes an overview on the available knowledges and information about the economic importance and distribution of yellow rust disease in Iraq, ranging from epidemiology to virulence spectrum, physiological races and the control measures. The information should be useful for devising strategies to eliminate the impact of the disease on wheat production, as well as understand the future risks of invasions at regional and global scale.

Keywords: Wheat yellow (stripe) rust; *Puccinia striiformis* f. sp. *tritici* (*Pst*); Cereals diseases; Disease resistance; Iraq

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Chapter 6

Wheat yellow rust in Egypt

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Summary: Wheat (*Triticum aestivum* L.) is a major winter crop and an essential source of carbohydrates and multiple nutrients, serving as a dietary food in Egypt. Wheat production in Egypt is not sufficient due to various factors, including rust diseases, which are the most destructive diseases of crop plants. In Egypt, yellow rust (*Puccinia striiformis* f. sp. *tritici*) has been considered to be the most severe disease of wheat, several epidemics have been reported during the last five decades. The book chapter attempts to provide a comprehensive overview of the status and importance of wheat rust along with the research done on various aspects ranging from epidemiology to race identification, molecular genotyping, resistance screening and resistance genes utilization, and disease management. The discussion is extended in the context of regional yellow rust situation with an emphasis on potential collaboration at regional level.

Keywords: Wheat; Yellow rust; *Puccinia striiformis* f. sp. *tritici*; Epidemics; Control; Egypt

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