PART III. Selected Management Practices for Rice Diseases

Rice Disease Management

Introduction

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Plant diseases can be controlled in various ways. Any chosen control measure must be based on a good understanding of the biology and epidemiology of the disease relevant to the ecological and socioeconomic conditions of the end-user. It is logical to identify the intervention point in the disease development process. So, when a control action is applied, it disrupts the advancement of the pathogen. This should stop the disease either by delaying its development or stopping the pathogen from producing secondary inocula. Such a measure will likely prevent the pathogen from developing further, resulting in sustainable and economical control of the disease it causes.

Plant pathology is an applied science that can be used towards solving plant disease problems in crop production. The technology used must be science-based. After the Green Revolution, organized efforts began that developed and used rice varieties that carry resistance (R)-genes effective for controlling some of the major diseases. However, other issues in disease management arose from planting varieties with different R-genes.

R-genes are limited genetic resources. Thus, the effective use and management of R-genes incorporated into the rice plant are as important as the development of resistant varieties for disease control. Resistance breeding is often aimed against a few diseases with high epidemic potential. In reality, rice suffers from the attack of many pathogens that result in different diseases. Some of these diseases have obvious symptoms while others are asymptomatic (see **Part II on the Biology of Rice Diseases**). Individually or collectively, pathogens can significantly curtail rice production. Besides knowing how to manage R-genes for controlling diseases, the other urgent issue is dealing with several diseases at the same time within a rice-growing season.

The above-mentioned issues are both scientific and practical. Most farmers in the rice-growing countries of South and Southeast Asia are either tenant farmers or small landholders who depend on rice farming for subsistence. Their rice crop management does not necessarily aim at disease control per se but at obtaining good crop growth, which will result a good harvest. Thus, it is desirable and feasible to identify farmer-friendly management practices that can provide a means to reduce disease occurrence.

Since the start of the Green Revolution in the mid-1960s, most modern rice varieties are disease resistant. It is safe to say that most varieties are resistant to two or three major rice diseases such as blast, bacterial blight, tungro, and some other tropical virus diseases. Whether or not such built-in resistance is durable deserves the attention of rice scientists. Past experiences have often shown that built-in resistance was not as durable as expected because the host plant and the pathogen coevolve and each responds to the other.

Can we deploy resistance systematically or "smartly" for more sustainable rice production? Can we arrest pathogen evolution into new virulent races that can overcome existing resistance? In this context, research must aim at host-pathogen [1]interactions, including farmers' cultural practices that can potentially minimize rice disease occurrence. Management options described here in **Part III**, especially resistance deployment, management of microbial antagonists, and rice seed health, have become cornerstones in our research. They have been integrated as components in rice crop management over the past four decades. The choice of practice is not arbitrary but based on research, specifically, epidemiological knowledge about disease development (**Section 1**).

Horsfall and Cowling (1977) called our attention to "make sure that our profession is useful" and pointed out that "understanding the economics of plant disease management is one of the greatest deficiencies" of our science. This online resource contains relevant information in this area. It also promotes a process to engage rice farmers for scaling up the technology of rice disease management lacking in most books and other information resources on plant diseases.

In the past, integrating knowledge from plant disease research into disease management practices has usually been left to the end-users, i.e., the farmers (Mew et al 2004). As stated 40 years ago by Horsfall and Cowling (1977), based on "cost-benefit analysis, alternative disease management strategies and tactics will probably become a part of plant pathologists' responsibility" in the future. Well, that future is now! To prove that pathology research is relevant and useful to farmers, it must address their concerns in crop production. Therefore, disease control needs to be integrated into crop management. This calls for involved players to be assigned to different but complementary disciplines in disease management and then work as a team. This is part of the new paradigm in which disease management comes to the forefront of rice disease control in the new millennium.

It is perilous to place reliance on plant resistance alone for disease management. How R-genes should be used in resistance breeding and how these genes should be deployed should inspire plant pathologists, plant breeders, crop physiologists, and socio-economists to form multidisciplinary teams to deal with these questions. In this context, we cite work on seed health management (**Section 2**) and genetic diversity (**Section 4**) to provide case studies that demonstrate the possibility of bringing together different disciplines to better manage the control of rice diseases.

Unlike integrated pest management (IPM) for rice insect pests, the strategy of "do nothing" to perturb the ecosystem by relying on natural enemies is not applicable to rice plant diseases (Way and Heong 1994). The balance comes from rational use of host plant resistance to avoid excessive swings in pathogen populations, which may lead to unchecked epidemics. For diseases that cannot be entirely controlled by host plant resistance, complementary measures, such as crop health management, can boost resistance of the system as a whole. Some strategies to make the system durable include introducing antagonistic biocontrol agents (**Section 3**) from seed or crop residue (straw) decomposition, rotating the use of genotypes with different R-genes, and diversifying with other crop species, especially on a rice-based cropping system to achieve system durability. Deployment of resistant varieties is an important approach to control many plant diseases, such as blast and tungro of rice, late blight of potato, leaf and stem rust and powdery mildew of wheat, barley, and or oats, just to mention a few. However, in reality, some rice diseases, such as sheath blight, do not have ongoing rice-breeding efforts for resistance because no sources of resistance are available.

What issues should plant pathologists be concerned with? The economics of disease control, environmental protection and the effect of climate changes on rice disease occurrence have not been explicitly considered until fairly recently. The idea of "disease management" has only gradually become an integral component of rice crop production (Mew et al 2004). As with the new modern rice varieties of the Green Revolution in the 1960s, some new alternate technologies of today's modern agriculture (such as raising seedlings on mats and using seedling boxes) often create new disease problems. Disease management should be ecologically sound and economically feasible. Agricultural ecosystems are "man-made" schemes that require continuous inputs of seeds, fertilizers, and irrigation that tips the scales in favor of the crop that farmers are growing (Zadoks and Schein 1979). It is an unbalanced system and difficult to maintain. Both excessive or deficient use of plant nutrients may result in crop injury. In this aspect we include an chapter on abiotic stresses to rice plant growth as a reminder of the issues.

It should be made clear that not all rice diseases need to be targeted for "control". Rice plants are attacked by many diseases but disease management strategies do not have to be designed to control all of them. Targeting selected diseases, specifically those with high epidemic potential, should suffice. Researchers should look for options to make the rice crop healthier, such as taking a "public health" approach, to minimize the need for disease control measures. Indeed, making the "rice production system" healthier is the best option. A healthy rice production system must start with sowing clean seed, already a practice that has been followed by farmers over the centuries. Planting healthy seeds will likely produce a healthy crop. To move the system forward, genetic diversity of rice varieties, as discussed in **Section 4**, specifically for disease resistance, plays an important role.

For general disease management, we promote a rice production system that begins with soil, seed, and crop health and then is combined with rice varieties with diverse R-genes. Proper management for crop health begins with land preparation and fertilizer application. Nutrient management, coupled with soil (land) management, can reduce the occurrence of certain rice diseases. Some of this is discussed in the biology of individual diseases in **Part II**. For example, silica has been evaluated and tested for the management of blast, brown spot, and other diseases. There is abundant information on the management of rice nutrients. The general concept of nutrient management is to provide the rice crop with adequate amount of nutrients during appropriate growth stages. While nutrient deficiency can hinder crop production, excessive fertilizer applications are not necessarily beneficial. In a **short video from the International Potash Institute**, Dr. Roland Buresh, former principal scientist at IRRI, explains further about nutrient management in irrigated rice. See more on nutrient deficiency and other abiotic stresses in **Section 5**.

In summary, pathologists, today, advocate disease management practices that do not necessarily target all possible pathogens that attack rice, but only those that can be responsible for very high disease potential. The general objective is to supply the rice crop with only essential amounts of nutrients to produce a healthy crop. Thus, in rice disease management, it is not our intention to provide a "shopping list" of measures as how individual diseases can be managed or controlled by different tactics. Instead, we provided some thinking of how a management strategy can be integrated into a production system from soil health to seed health and crop health to achieve total disease management for crop production.

References

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