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Wheat Blast: Potential Plant Pandemic Threatens Global Food Security

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Introduction

The world's population is expected to increase from 8 billion in 2023 to 9.1 billion in 2050.The existing food security problem could get worse as a result of this rapid population growth. Currently, 815 million people worldwide (or one in nine) lack adequate nutrition, while 2 billion experience hidden hunger as a result of micronutrient deficiencies. In order to guarantee the food security of the expanding population by 2050, it is predicted that the net food supply must be increased by 70%. While it is imperative to supply more food and more micronutrient-enriched food, the recent spread of lethal crop diseases has been continuously creating severe threats to food security. More than a billion people in South Asia now face serious threats to their food security as a result of the outbreak of the wheat explosion in Bangladesh. According to a recent studyover 7 million ha (17.1%) of the 40.85 million hectares of wheat fields in Bangladesh, India, and Pakistan are susceptible to wheat blast. Currently, rice is the main staple meal in Bangladesh, whereas wheat, the second most common staple food after rice, has been gaining popularity in India and Pakistan .

Wheat blast is a fungal disease that can devastate wheat crops, causing yield losses of up to 100%. The disease was first identified in Brazil in 1985 but has since spread to other countries in South America and, more recently, to Asia, including Bangladesh, India, and Cambodia. Wheat is one of the world's most important food crops, and a major source of nutrition for billions of people. If wheat blast were to spread to major wheat-producing regions in Asia, it could have a severe impact on global food security. The disease could

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potentially destroy entire wheat crops, leading to food shortages and rising prices for wheat-based products. The spread of wheat blast is particularly concerning because it is a fast-moving disease that can spread quickly through infected seeds, plants, or soil. Once it has established itself in a new area, it can be difficult to control or eradicate. Additionally, there are currently no resistant varieties of wheat that can withstand the disease. In a new study, scientists have warned that a disease known as 'Wheat blast', which originated in South American wheat crop, has the potential of developing into a plant pandemic by spreading worldwide. A fungus called Magnaportheoryzae is responsible for the 'wheat blast' disease. Researchers first detected the pathogen in Brazilian wheat crops in the 1980s. The fungus has since spread throughout South America. Since then, its outbreak has spread to two other continents. It has been reported in parts of Asia and Africa. In some areas, the situation became so severe that the fungus destroyed the entire crop. *Magnaportheoryzae* infects wild and cultivated grasses, most notably rice and wheat. The latest research published in the journal Plos Biology noted that the pathogen is resistant to fungicides and has the potential to affect not only wheat but also other major food crops. Over the years, the fungus has migrated to different parts of the world and has undergone several mutations. In 2016, Bangladesh reported the first outbreak of a 'wheat blast' in Asia. This led to a loss of 51% in crop yield that year. Two years later, an outbreak of this fungus was detected in wheat crops in Zambia, which was the first time the pathogen was detected in Africa. However, it is not clear whether it reached Zambia from Bangladesh or South America. During the study, scientists analysed more than 500 samples of the fungus to understand the origin of the pathogen. Genomic analysis of fungus samples from all three continents showed that these fungi are part of the same family. The result suggests that the strain of wheat blasts from South America independently reached Africa and Asia which could mean that humans are likely transporting these pathogens. Before the outbreak in Bangladesh, the country had received a large number of wheat seeds from Brazil. This suggests that importing infected seeds is a possible outbreak source. However, there is no concrete proof to pinpoint the origin of the fungus in Brazil as of yet. Research has shown that the fungus responsible for the outbreak is susceptible to certain fungicides, but laboratory experiments have shown that resistance can arise through spontaneous mutations. Lessons from South America suggest that eradication is difficult. That is why we need to manage it effectively through monitoring.

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Genomic surveillance allows for early and accurate detection of these, which can lead to the discovery of the origin of the disease and then help create a prevention strategy. Wheat is one of the most consumed grains in the world and crores of people can reach the brink of starvation, that too in the poorest parts of the world, in case of a 'Wheat blast' pandemic. That's why more efforts are needed at the early stage to contain the spread and minimise its impact and if possible, eradicate it, before it is too late.

Emergence and Spread of Wheat Blast

Wheat blast, often known as "brusone," is brought on by the haploid, filamentous, ascomyceteous fungus Magnaportheoryzae(also known as PyriculariaoryzaeCavara 1892). Under the correct environmental circumstances, blast has emerged as an explosive danger to wheat production that might result in up to 100% yield losses . In the Brazilian state of Paraná, commercial wheat fields in six municipalities were seriously impacted by wheat blast for the first time in 1985 . By 1986, the illness had expanded to Mato Grosso do Sul's south, western So Paulo State, and northern and western Paraná. Blast was soon discovered in other significant wheat-producing areas of Brazil . In Bangladesh's districts of Kushtia, Meherpur, Chuadanga, Jhenaidah, Jessore, Barisal, Bhola, Magura, Narail, and Faridpur in 2016 a wheat blast outbreak was observed for the first time outside of South America (Malaker et al. 2016). 15% of Bangladesh's total wheat land was impacted by this first wheat blast incident. Comparative genomic analysis revealed that the extremely aggressive MoT isolates from South America were closely linked to the fungal isolates from different wheat locations in Bangladesh, which looked to be clonal (Malaker et al. 2016). The Bangladeshi wheat blast fungus was most likely brought in from South America, according to an independent pathogenomics analysis (Islam et al. 2016). This widespread outbreak of wheat blast outside of South America has highlighted worries about the potential similar to other South Asian and global wheat-producing regions, including Bangladesh.

Conducive weather for wheat blast

Wheat blast is particularly devastating because it spreads quickly and gives farmers little opportunity to take preventive action. Wheat blast formation is greatly influenced by weather conditions. Wheat blast disease has been reported to develop and occur more frequently under wet and humid weather during the heading stage of wheat crops.Plant organ infection, cultivar susceptibility, and climatic variables all have a significant role in determining how severe a head blast is. Between anthesis and early grain development is the growth stage that is most susceptible to yield decrease .The occurrence of the illness has been supported by a number of conditions, including increased warmth, rainfall during the flowering stage, and leaf/spike wetness (Islam et al. 2019).The seasons with the most severe field infections are those with continuous rain throughout the anthesis phase, with an average temperature of 18 to 25 °C, and then a period of sunny, hot and humid weather following (Kohli et al. 2011). According to Cardoso et al. (2008), a serious outbreak of the disease can occur when the ideal temperature is between 25 and 30 °C and there is an increase in wetness over 25–40 hours. The Bangladesh Meteorological Department's weather data analysis reveals that the temperature rises in 2016 happened in all regions and was mostly caused by a 1.8–6.5 °C increase in the minimum temperature compared to 2011–2015 (Islam et al. 2019). The districts in Bangladesh impacted by the wheat blast in 2016 likely developed an epidemic as a result of this temperature and rainfall during the flowering season.

Disease Symptoms and Diagonosis

According to Islam et al. (2016), the wheat blast disease is essentially a neck blast because under a favourable environment, symptoms first occur in the spikes. However, wheat's entire aerial structure exhibits illness symptoms. Older leaves develop eye-shaped patches and gray-green, water-soaked leaf lesions with dark green borders as foliar symptoms (Islam et al. 2019, 2020). The most noticeable signs of wheat blast are blackened rachises and partially or totally bleached spikes (frequently mistaken for indications of Fusarium head blight). The majority of the time, grains from heads affected by blasts are small, light in colour, wrinkled, malformed, and have a low test weight. The wheat blast significantly modifies the biochemical and antioxidant properties of wheat grains (Surovy et al. 2020). When head infections begin when wheat plants are in the blooming or early grain formation stages, the yield losses are the greatest (Islam et al. 2020). We know very little about the biology of the wheat blast pathogen and how it interacts with host plants.

Transmission of pathogen

According to Islam et al. (2020), the disease wheat blast is spread by seeds. But in epidemiology, seed infection might not be as significant. Conidia from secondary host grasses spread through the air and cause the spike infection. Although the plant species that harbour the MoT pathogen has not yet been clearly identified, it is thought to persist on wild plants along field boundaries and in open grasslands between wheat crops. Numerous weeds and grass species are secondary hosts and are frequently seen in wheat fields, however it is unclear how they contribute to wheat blast epidemiology. Clarification is needed regarding the possible contribution of lower and older wheat leaves to the accumulation of inoculum prior to ear emergence. Eleusine species and "Brachiaria" ("Urochloa") grasses have been discovered to be the main secondary hosts of "MoT" in Brazil. Regarding Bangladesh's secondary MoT hosts, no information is provided.

Control of wheat blast

Although there isn't a variety that is resistant to wheat blast, some cultivars have demonstrated mild tolerance to it. Therefore, it is necessary to develop resilient wheat cultivars that can withstand wheat blast. The use of endophytic Bacillus species and bacterial secondary metabolites for the biological control of wheat blast disease has shown great promise.The following approaches are suggested to manage the wheat blast disease in the practical field.

1. Improved wheat varieties that carry genetic resistance to M. oryzae.
2. Global monitoring of disease appearances, movement, and evolution, in coordination with local governments and research agencies, as well as predictive models.
3. Advanced studies on potentially effective, safe, and affordable chemical control measures.
4. Genetic and epidemiological research to strengthen knowledge of the fungus and its interactions with wheat and other host plants.
5. The development of a durable resistant wheat variety through biotechnological interaction is badly needed.

Conclusion

Wheat blast is a fungal disease that affects wheat crops, causing significant yield losses and threatening food security in affected regions. The disease was first identified in Brazil in 1985 and has since spread to other countries in South America, including Bolivia, Paraguay, and Argentina.Wheat is a staple food crop in many parts of the world, and any threat to its production can have serious consequences for food security. Wheat blast can cause up to 100% yield losses, depending on the timing of infection and the susceptibility of the wheat variety. In addition to reducing yields, the disease can also affect the quality of the grain, reducing its nutritional value.The impact of wheat blast on food security is particularly severe in regions where wheat is a primary food source, and where farmers rely on the crop for their livelihoods. For example, in parts of South Asia, where wheat is a major staple crop, an outbreak of wheat blast could have devastating consequences for the region's food security.Efforts to control wheat blast have focused on developing resistant wheat varieties, improving disease surveillance and monitoring, and promoting good agricultural practices to reduce the spread of the disease. However, more research and resources are needed to effectively manage the disease and prevent its spread.

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