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Loose Smut in Wheat: Understanding the Life Cycle of *Ustilago tritici* and Seed Treatment

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ABSTRACT

The fungal pathogen *Ustilago tritici* is the source of loose smut of wheat, a devastating seedborne disease that has a major impact on seed quality and wheat yield. Fungal spores infect the developing embryo during the blooming stage, resulting in an infection that is both systemic and internally concealed. Inside the seed, the fungus is dormant; when it germinates, it becomes active and grows with the growing plant. It continues the disease cycle by replacing the normal grain at heading with masses of black spores that are discharged and spread by wind. Disease spread is encouraged by favorable climatic factors, particularly high humidity and moderate temperatures during flowering. Significant production losses and decreased seed marketability are among the economic effects. Using certified disease-free seed, resistant cultivars, and above all treating seeds with systemic fungicides are essential for effective management. Implementing efficient control measures and reducing crop losses require an understanding of *Ustilago tritici's* life cycle and epidemiology. Significant production losses and decreased seed marketability are among the economic effects.

Keywords: Wheat Disease, Loose smut, Rust diseases, Fungal disease, Economic Importance

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Introduction

Approximately 15% of the world's total cereal crop planting areas are devoted to the production and marketing of wheat (*Triticumaestivum L.*). It is a significant food and industrial grain that is sold globally and is ranked second in importance among cereal crops worldwide after rice. Wheat is a critical commodity that increases agricultural revenue and food security in sub-Saharan African nations. Wheat is produced in many African nations for both domestic use and export, though production and sales levels differ from one nation to another [1]. About 205 of the calories consumed by humans worldwide come from wheat alone. It produces more than 760 million tons annually on an area of 219 million hectares. The USA is the world's second-largest exporter and fourth-largest producer of wheat. Therefore, one of the most crucial objectives of current agricultural policy is to increase wheat yields throughout the ensuing decades in order to ensure that the consumption needs of future generations are met [2]. The primary factors influencing the rheological characteristics of drought which in turn reveal the quality of a particular wheat are the makeup and ratios of the various gluten fractions. The majority of the criteria of the multi-feature technique, which enables the classification of wheat into several qualitative groups, are therefore related to the quantitative and qualitative evaluation of gluten [3]. Identifying wheat infections is one of the crucial jobs. It costs a lot of money and effort to identify these diseases, and either farmers or plant disease specialists can do it. Wheat diseases (WD) are crucial because farmers and enterprises suffer financial losses due to delayed detection and prediction. Spray equipment is used to control the fungicide, but numerous researchers have noted that a shortage of the equipment not only makes it difficult to control the outbreak in a timely manner, which can lead to serious health problems, but also raises concerns about the safety of farmers who use the equipment to control the fungicide in the fields [4]. Russet disease, an airborne fungal illness brought on by a group of fungi from the *Pucciniales* order, significantly reduces its productivity rate. Food security is seriously threatened by this disease since it can damage the crop within a month of its initial attack and reduce wheat output rates by up to 30% [5]. Bunts and smuts are among the biotic and abiotic variables that lower wheat and barley grain production.

Despite causing lower yield losses than other dreaded diseases, such as rusts, bunts and smuts are significant from a trade standpoint since they are quarantined in many countries, such as the Karnal bunt. By substituting fungal spores (teliospores) for the seed tissue and producing a distinctively unpleasant odor from trimethylamine, they have an impact on yields and quality. Wheat and barley crops are impacted by six distinct diseases: dwarf bunt (*Tilletia controversa*), flag smut (*Urocystis agropyri*), covered smut of barley (*Ustilago segetum var. hordei*), loose smut (*Ustilago tritici and Ustilago nuda*), common bunt/hill bunt (*Tilletia laevis and Tilletia tritici*) and Karnal bunt (*Tilletia indica*). The main cause of seed infection is teliospores, which can linger in soil for a very long period [6].

Symptoms / Life Cycle of *Ustilago tritici*

The fungus *Ustilago tritici* is the cause of wheat's loose smut disease. Until the plant reaches maturity, the infection is concealed. The earliest obvious signs show up during the heading, when a black, powdery mass of spores called smut spores or teliospores replaces the ear (inflorescence) that would normally produce wheat grains. Compared to healthy heads, these smutted heads typically emerge earlier and are longer. The spores are eventually dislodged by wind or mechanical disturbance, leaving behind the spike's center stalk, often known as a "naked rachis."[7]. A healthy wheat plant's blossoming stage marks the start of *Ustilago tritici's* life cycle. Spores of smut that are airborne land and germinate on the exposed florets. A systemic infection results from the fungal hyphae's penetration of the ovary and entry into the growing embryo. The diseased seed appears healthy because this infection is inside and invisible from the outside. Throughout storage, the fungus stays latent inside the seed embryo. The latent fungus turns active when the infected seed germinates and grows systemically with the expanding seedling. The fungus invades the floral sections of the plant when it enters the reproductive stage replacing them with masses of black spores that are then released to restart the cycle Fig.1 [8].

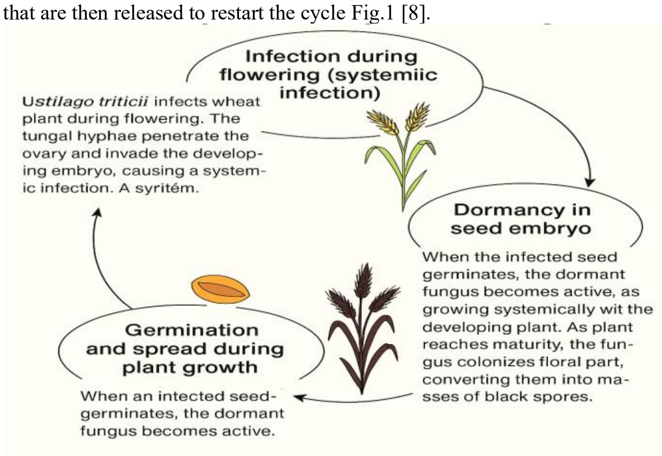

Fig. 1: Life Cycle of *Ustilago tritici* (Loose Smut of Wheat)

Environmental Conditions for Disease Development

Certain environmental and agronomic conditions have a significant impact on the development of loose smut disease, which is caused by *Ustilago tritici*. When smut spores are released and fall onto the exposed florets during the wheat crop's flowering stage, the conditions for infection are at their most favorable. When smut spores are released and fall onto the exposed florets during the wheat crop's flowering stage, the conditions for infection are at their most favorable. Temperature and humidity are two of the most important environmental elements [9]. Disease growth can be further accelerated by agronomic techniques such using untreated or contaminated seed, cultivating vulnerable wheat types and dense planting that produces a humid microclimate. Seed treatment and selection are essential in preventing disease because infected seeds that are not visually distinct from healthy ones allow the fungus to survive undetected [10].

Economic Impact of *Ustilago tritici*

Because of yield losses and seed quality degradation, Ustilago tritici has a substantial economic impact on wheat production. A direct decrease in yield results from infected wheat plants producing smutted ears rather than spikes that carry grain. Depending on the environment and the severity of the infection, yield losses in extreme situations, particularly when infected seeds are sown untreated, might vary from 5% to 30% [11]. Additionally, these seeds might be subject to regulatory limitations in seed certification schemes, which would cost farmers money. Additionally, because purchasers frequently reject grain lots tainted with fungal spores the presence of smut in the field lowers the crop's aesthetic and commercial worth. All things considered, *Ustilago tritici* is a major danger to profitable and sustainable wheat farming [12].

Conclusion

A hidden but significant threat to wheat output is loose smut of wheat, a fungal disease spread by seeds and brought on by *Ustilago tritici*. Early identification is challenging because the pathogen remains dormant within the seed embryo and infects the crop systemically during the flowering stage. The fungus grows with the afflicted plant eventually replacing the spikes that bear grain with masses of powdery black spores. The disease spreads more easily under favorable circumstances, such as high humidity and moderate temperatures during flowering. The main economic effects of this illness are decreased marketability, low seed quality and yield losses. Effective seed treatment is crucial to preventing this illness. Systemic fungicides can be applied to seeds prior to sowing in order to destroy the latent mycelium and stop the disease from growing throughout the following crop cycle. Important preventive measures also include adopting resistant wheat cultivars, utilizing certified disease-free seed, and applying appropriate crop management techniques. Comprehending the life cycle of *Ustilago tritici* is essential for creating focused control plans and guaranteeing robust, fruitful wheat crops.

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