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The Impact of *Septoria tritici* Blotch Disease on Wheat (*Triticum aestivum*): In Ethiopia - A Review

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Abstract: **Wheat (Triticum aestivum) is Ethiopia's most important grain crop, but disease, particularly Septoria tritici blotch (STB) caused by Zymoseptoria tritici, has a significant impact on its production. Zymoseptoria tritici is a common disease found in wheat-growing areas around the world including Ethiopia. Therefore, it is crucial to evaluate the host crop, the fungal pathogen, and their common environment in order to properly comprehend STB. In this review, the economic importance of wheat in Ethiopia as a food and animal feed crop, the impact of STB fungus and how it interacts with its host, the climate and weather elements that determine its incidence and severity, as well as agricultural strategies that may minimize or improve its impact on crop yields was assessed. Integrated disease management measures such as resistant breeding, cultural management and fungicide application has also be highlighted as effective and long-term disease management practices.**

Keywords: **Incidence, *Septoria Tritic*e Blotch, Severity, Wheat, Yield Loss.**

1. INTRODUCTION

Wheat (*Triticum aestivum*) is the third most widely produced cereal crop in the world and the most important major crop in Ethiopia. It ranks the fourth after tef (*Eragrostis tef*), maize (*Zea mays*) and Sorghum (*Sorghum bicolor*) in area coverage and third after Maize and tef in total production (Letta *et al.*, 2013). Next to South Africa, Ethiopia is the second largest wheat producer in Sub- Saharan Africa (Mekonnen *et al*., 2020).

Despite its broader production coverage and diverse uses, Ethiopia's average wheat crop productivity is 2. 8 t/ha, which is lower than the global average of 3.27 t/ha (Said and Hussein, 2016). Wheat production in Ethiopia is hampered by the conventional production system, lack of inputs, and biotic and abiotic stress. It is susceptible to more than 30 diseases in the countries, many of which have a significant impact on yield and yield components (Hailu and Woldeab, 2015).

The ascomycete *Mycosphaerella graminicola* (asexual stage: *Zymoseptoria tritici*) causes *Septoria tritici* blotch (STB), which is the most severe wheat fungal disease in Ethiopia (Takele *et al*., 2015; Mekonnen *et al*., 2019; 2020) and elsewhere in the world (Eyal *et al*., 1985). The disease is primarily a foliar disease, with asexual pycnidospores and sexual ascospores from contaminated crop debris spreading by airborne or rain splashed asexual pycnidospores and sexual ascospores. STB could reduce production by 30 to 70% in ideal growing circumstances, with high relative humidity (85%) and optimal temperature (22°C) (Eyal *et al*., 1987). Wheat production losses of up to 82 percent have been reported in Ethiopia (Abreham, 2008).

STB has been the subject of a lot of studies in Ethiopia's major wheat-growing regions. Reviewing multiple studies in one document is critical, and it is frequently used as a reference for policymakers, researchers, and others interested in learning more about wheat production and STB. Of course, Binalf and Shifa (2018) published a review paper titled

Septoria Tritici Blotch of Bread Wheat (*Triticum aestivum* L.): Effect and Management Options. But only a small portion of the work on evaluating STB paperwork in the country has been completed. Hence, it is critical to examine additional research studies, identify gaps, and provide future directions and information on how to reduce the risk of STB on wheat production and productivity in the country.

2. THE IMPORTANCE OF WHEAT AS ETHIOPIAN CROP

Agriculture is an important part of Ethiopia's economy, accounting for more than 85% of the country's national gross domestic product. For millions of Ethiopian households, agriculture in general and cereals in particular provide a source of income. Crop production is a significant contributor to GDP, accounting for roughly 28% of all agricultural sub-sectors (NBE, 2018). Crops account for the majority of total production and area coverage, accounting for 68 percent of Ethiopia's agricultural gross domestic product on average. Wheat is one of an important cereal crop that contributes significantly to the development of the agricultural sector in general and to the food security states of farm households in particular (Dessale, 2019).

In Ethiopia, both bread wheat (*Triticum aestivum* L.*)* and durum wheat (*Triticum turgidumssp. durum* L.) are widely produced for food, feed, and revenue generation. It is used to make a variety of traditional and modern processed foods, including injera and other industrially processed foods like pasta and macaroni (Nigussie *et al*., 2015). Wheat straw is also extensively used as a roof tacking material and as animal fodder. Wheat and wheat products account for 14% of total calorie consumption in the country, making wheat the second most significant food after maize (19%), followed by tef (12%), sorghum (11%) and enset (12%) (FAO, 2014).

Wheat production and productivity have increased throughout the country, particularly between 2005 and 2017. It is grown exclusively under rainfed circumstances, and its output is outpacing that of all other grain crops in the country (Anteneh and Asrat, 2020). In terms of estimated yield, the CSA, (2018) report stated that wheat in the category of cereals has demonstrated a rising range of 2.28 to 29.67 quintals per hectare over the 5 years (2012/2013–2017/2018) post-harvest estimates. Its production is expanding as a result of a number of government programs and efforts aimed at boosting agricultural growth and food security in the country. There is also significant annual variance due to variation in rainfall, which indicates that if the rainfall is good, so is the production, and if the rainfall is bad, so is the output (Gebreselassie *et al*., 2017).

2.1 Potential wheat-producing areas in Ethiopia

Ethiopia's main wheat-growing regions are in the country's central, south-eastern, and northwest highlands. Oromia (57.4%), Amhara (27%), SNNP (8.7%), Tigray (6.2%), and others (0.7%) account for the majority of national wheat production (CSA, 2014). Wheat is grown throughout Ethiopia's northern, central, and south-eastern highlands. Ethiopia's Oromia and Amhara areas produce the majority of the country's wheat (85 percent) (Bergh *et al.*, 2012). East Shewa (ESH), West Shewa (WSH), South West Shewa (SWSH), North Shewa (NSH), Oromia special zone (OSZ), ARSI, West Arsi (WARSI), and BALE account for 75% of the country's total wheat producing areas (Mekonnen *et al*., 2020).

The main wheat-growing zones in the country are the Bale and Arsi zones. As a result, these two zones are known as the Belt of Wheat Production Areas (Bergh *et al*., 2012). SNNP, on the other hand, has the smallest wheat-growing area, with an average of 0.19 hectares per farm. In Amhara, Tigray, and adjacent locations, the average wheat acreage per farm is between 0.28 and 0.39 hectares (CSA, 2017, 2018). In terms of total output and area coverage, Ethiopian wheat is mostly produced in the Oromia, Amhara, and SNNP areas. It is produced in practically all parts of the country, including pastoral and agro-pastoral regions such as Afar, Gambela, and Somalia (Bergh *et al.*, 2012)

2.2. Wheat production and marketing constraints in Ethiopia

In comparison to the greatest achievers and model farmers who managed to generate more than 6 t/ha (CSA, 2015), the average national productivity is less than 2.5 t/ha (EIAR, 2012). Lack of adequate agronomic methods, weather uncertainty, weeds, insects, and disease outbreaks are all posing production issues. The widespread disease, STB, causes significant qualitative and quantitative yield losses (Azanaw *et al.*, 2017). Due to this, the country imports over 180 million quintals of wheat each year (Dessale, 2019). Wheat production is largely farm to fork, meaning farmers produce more for their own consumption rather than for the market .This is owing to the fact that there are various production limits. These factors contribute to lower wheat production and productivity, as well as incompetence and market underdevelopment Gebreselassie *et al.*, 2017).

Production and marketing constraints in Ethiopia's farmers' are due to lack of knowledge about enhanced crop management practices which results in a loss of their incomes. One of the reasons for loss during cultivation, harvesting, threshing, and even storage and sale is the use of less crop management practices. Parallel to this, wheat farmers and traders faced major marketing constraints such as lack of timely and sufficient market information, a low price of the product at harvest time, weak market linkages among value chain actors, trader price cheating, and less bargaining power of farmers in the market, as well as unfair competition from illegal traders (Gebreselassie *et al.*, 2017).

3. OCCURRENCE AND GEOGRAPHICAL DISTRIBUTION OF *SEPTORIA TRITICI* BLOTCH

STB is a worldwide problem affecting wheat-production in Europe, Australia, Canada, the United States, Argentina, Iran, Netherlands, Russia, New Zealand, Australia, Tunisia, and East Africa including Ethiopia (Ponomarenko *et al*., 2011). The early1960s, *Z. tritici* was not perceived as an economically significant pathogen on wheat. However, with the introduction of dwarf wheat varieties, this pathogen has become a problem causing considerable grain yield loss, especially during growing seasons with significant rainfall (Palmer and Skinner, 2002).

STB are widely dispersed and showed large variability in all wheat growing area of the country. According to Hailemariam *et al*. (2020), several studies on the distribution and occurrences of STB in major areas of wheat production in Ethiopia were performed and reported. It is a serious wheat disease that affects Ethiopia's all wheat-growing regions (Mekonnen *et al.*, 2020, Tadesse *et al*., 2020). The occurrence and distribution of STB wheat disease in Ethiopia has been reported in several studies (Stewart and Dagnachew, 1967; Eshetu, 1985; Mekonnen *et al*., 2020; Tadesse *et al.*, 2020.) This disease has spread throughout the country's wheat-growing regions (Hailu and Woldeab, 2015, Takele, *et al*., 2015, Azanaw *et al*., 2017, Mekonnen *et al*., 2020, Tadesse et *al.*, 2020). It has become one of the country's most destructive wheat diseases (Hailu and Woldeab,2015, Teferi and Gebreslassie, 2015; Takele *et al*., 2015), with increasing incidence and severity in all wheat-growing areas (Teklay *et al.* 2015, Mekonnen *et al.*, 2019, Tadesse *et al*., 2020).

STB disease is found in every major wheat-producing region in the country. This could be owing to the regular occurrence of rust outbreaks, which prompted the wheat breeding program to concentrate on the introduction and production of rust-resistant wheat genotypes, but STB-susceptible commercial cultivars (Admassu *et al.*, 2012).

4. PREVALENCE OF *SEPTORIA TRITICI* BLOTCH

STB incidence and severity on wheat is very high across surveyed locations in Ethiopia.. According to Hailemariam *et al.* (2020), the highest STB prevalence (100%) were found in the highlands of Wollo, Ethiopia, with the lowest STB prevalence (33%) found in various locations (Meket, Woreilu, Wadila, Jama, and Dessie Zuria) and varieties. The disease is economically significant and widespread throughout Ethiopia's wheat-growing regions (Said and Hussien, 2016). According to Binalf and Shifa (2018), none of the genotypes are immune to STB. It is the most lethal disease in the West and South West Shewa zones, with the disease's overall distribution/prevalence reaching 100%. STB and leaf rust are the two major diseases limiting wheat yield in the most potential areas of wheat production zone of Ethiopia, Arsi and Bales (Hailu and Woldeab, 2015). Tadesse *et al*. (2019) observed the highest STB disease incidence (98%) and disease severity (97%) in the Central highlands of Ethiopia, Holetta on naturally evolved susceptible varieties.

STB incidence and severity varied from season to season and from location to location (Teklay *et al*., 2015). The authors claim that the disease's incidence and severity have grown by 50%. Azanaw *et al.* (2017) also stated that STB is the most frequent and devastating disease in Ethiopia's North Gonder wheat agricultural region, according to (In such places, there has been a documented maximum disease incidence (100%) and severity (70%). The highest prevalence of STB has also been recorded in Wadila (87%), Jama (80%), Woreilu (80%), and Meket (80%) (Hailemariam *et al.*, 2020).

In another study by Tadesse *et al*. (2018) the prevalence of STB in Ethiopia's central highlands was varied from 52 to 75% among the three zones (South west, west and North shewa zones). In the same way, the average severity ranged from 45 to 83% percent. They also confirmed that practically all wheat cultivars grown in the research area are susceptible to STB. They suggest that enhanced wheat types are susceptible to STB. In North Shewa, STB prevalence ranged from 0% to 100%, with an average value of 98% (Tadesse *et al.*, 2018).

According to Teklay et *al,* (2015) STB are found in 53% of the surveyed fields in 2011, with an average incidence and severity of 14% and 19%, respectively. Similarly, the disease was prevalent in the 2012 and 2013 cropping seasons, with prevalence rates of 64% and 38% respectively.

As the survey conducted on Rust and STB Diseases prevalence showed, STB are the most frequent disease of Wheat in Central Ethiopia (Hailu and Woldeabs, 2015). In the examined locations, stem, leaf, and yellow rust had mean incidence values of 54.7%, 19.4%, and 7.7%, respectively. The respective mean severity values were 7.0%, 9.7%, and 5.5%. Whereas STB had greater average incidence of 83% in the same study areas.

STB incidence is not considerably different among kinds at the time of disease onset, regardless of location. Gradually, considerable disparities in STB incidence emerged among the types. STB prevalence varied among locations, genotypes, planting dates, growth stages, previous crops, plant population, weed population, and soil types (Hailemariam *et al.* 2020). Similarly, disease intensity also varied along all independent variables. According to them in the highlands of Wollo Ethiopia, the incidence of STB is governed partly by prior crops; STB is the most prevalent in previously cultivated wheat areas, while it is least prevalent in previously cultivated legume and barley fields. At different planting seasons, varied degrees of STB prevalence are visible, with the highest prevalence in June and the lowest prevalence in August. The high plant population had the highest STB prevalence as compared to the low plant population. When compared to a low marijuana population, a high weed population resulted in a high STB prevalence. The incidence of STB also varies by soil type, with red soil having the highest prevalence (94%) and black soil having the lowest (0%).

5. YIELD AND YIELD COMPONENTS LOSS BY *SEPTORIA TRITICI* BLOTCH

STB causes considerable yield losses worldwide, and it is currently a major challenge in Ethiopia's wheat production (Mekonnen *et al*., 2020). The majority of high-yielding wheat cultivars grown in Ethiopia now are vulnerable to STB, and there are no entirely resistant variants (Teklay *et al,* 2015). Wheat production and yield loss as a result of this disease in the country can reach 82 percent in hot spot areas on sensitive types SLB disease threatens wheat-growing areas in Ethiopia, particularly highly productive districts (Abreham, 2008).

STB are more severe in Ethiopia's Central Highlands, according to (Tadesse *et al.*, 2020). They claim that the current high-yielding wheat varieties are the most sensitive to STB. They found that on natural infections plots of this variety yield loss up to 39%. Plant tillering, reduced seed set, poor grain fill, loss of TKW, and loss of shriveled grain with chaff during harvest diminish grain production and test weights. As a potential wheat production problem Seide and Hussien, (2016) confirmed that this disease caused significant losses in yield and yield components of all varieties studied, and it is a potential wheat production problem. Disease severity and incidence have highly substantial and negative associations with yield and yield components (grain production, spike length, plant height, kernel weight per spike, kernel number per spike, thousand seed weight, and hectoliter weight) (Tadesse *et al.*, 2020).

Grain yield is the most critical and economically significant characteristic that is influenced by disease. STB is also has a considerable impact on it (Said and Hussein, 2016). Variations in STB epidemic levels have an impact on grain yield and yield components losses. They claimed that STB caused a reduction of grain yield and yield components in all studied types in the SNNPR's Kembata tembaro and Hadya zones. They have been agreed upon (Eyal *et al.*, 1987) STB infections can cause economic losses not just in terms of grain output, but also in terms of quality, as the kernels of vulnerable wheat cultivars become shriveled and unfit for processing. Another study found that untreated plots of the susceptible type in Ethiopia's Central Highlands lost up to 39 percent of their grain yields (Tadesse *et al.*, 2020).

The crop's thousand kernel weight (TKW) is one of the yield parameters that are influenced by wheat foliar diseases. Wheat heads with severe STB infection are usually shriveled and light (Tadesse *et al.*, 2020). Unsprayed fields resulted in losses of up to 36%, according to Seide and Hussen (2016). TKW losses have reached up to 25% during natural epidemic (Tadesse *et al,* 2020). They corroborate with previous reports by Takele *et al*. (2015), who found that thousands of seed were lost owing to STB, with a loss rate of 36%. The disease's influence on the seed's size and mass is mostly responsible for the decrease in TKW (shriveling of the kernels).

STB has a substantial impact on biomass weight in Ethiopia. The highest losses in biomass weight are observed on the natural epidemic around 48 percent, which also had the highest disease severity. Under natural epidemic studies on susceptible variety experienced the largest loss in number of kernels per spike of 35.9%. The vulnerable wheat variety suffered the greatest loss in number of kernels per spike during the natural outbreak and reach up to35.9% (Seide and Hussen, (2016).

6. ENVIRONMENTAL FACTORS AND CULTURAL PRACTICES IMPACT ON *ZYMOSEPTORIA TRITICI* AS A WHEAT PATHOGEN IN ETHIOPIA

The growth of STB is influenced by environmental variables, growing practices, and reactions. This could be due to increased humidity levels at higher altitudes, as well as the maximum level of infection on wet, overcast days with high relative humidity (Kema *et al.*, 1996). In Ethiopian the development of disease is aided by favorable climatic circumstances (Hailemariam *et al.*, 2020). Infection levels are high in practically every study area and every year of the study (Teklay *et al.*, 2015, Hailemariam *et al.*, 2020, Mekonnen *et al.*, 2020, and Tadesse e*t al.*, 2019, 2020). STBs favorable growing conditions are high relative humidity (85%) with an optimal temperature (22°C). The ideal temperature for wheat development also varies from 20-25°C for proper plant development. According to different survey results, these optimum environmental circumstances are the cause of STB occurrences in most wheat-growing areas of the country, every year. Wheat genotypes' sensitivity is also increased by prevalent climatic conditions that are favorable for its development (regular rains and moderate temperatures) as well as a pathogen population with a larger pathogenicity spectrum (Teklay *et al.,* 2015).

Wheat cultivars that are resistant in one area may be susceptible in another, demonstrating the lack of consistency in response. This could be due to changes in weather, which could affect host resistance to the disease or pathogen population variance. According to Tadesse *et al*., (2020), due to more favorable environmental conditions prevalent during the crop growth season, such as rainy, chilly, and acceptable average monthly maximum temperatures ranging from 19°C to 27°C, the Central Highlands of Ethiopia had the highest severity and incidence of STB. As a result, environmental condition must be taken into account while developing STB management strategies. They showed that the fungicide's inability to reduce STB severity to zero is related to the presence of favorable climatic conditions for STB development during the growing season, such as enough rain and a comfortable temperature. Rainfall is not only beneficial to the development of STB, but it can also diminish the efficacy of fungicides.

6.1 Association of *septoria tritici* blotch with altitude

Wheat is widely grown in Ethiopia at a variety of altitudes. The country's wheat production zones are located between 6° and 16° north, and 35° and 42° east, at elevations ranging from 1500 to 3000 meters above sea level. However, the best location is between 1700 and 2800 meters above sea level (Endale and Getaneh, 2015).

The severity of the disease also varied with altitude. It is more severe at higher elevations than at lower elevations. According to Azanaw *et al.,* 2017 the districts of Dembia and Takusa (mid elevations) had the lowest severity (0%). Similarly, they discovered that as altitude climbed, the incidence level increased. According to Hailemariam *et al.* (2020) STB diseases are widely spread in wollo districts with altitudinal variations, they discovered that as altitude grew, so did the incidence and severity of the disease. The incidence and severity of STB both increased as altitude increased. This might be attributed to higher level of humidity at higher altitude and highest level of infection on rainy cloudy with high relative humidity and more prevalent during cool, wet weather. It is generally more severe in districts above 2700 masl than at lower elevations, similarly, as altitude increased, the incidence level increased.

6.2 Association wheat *septoria tritici* blotch intensity with cultural practices

STB infection occurrence and severity were also influenced by cultural practices. Higher plant populations have the highest disease incidence and severity of STB, whereas lower plant populations have lower disease incidence and severity. According to Hailemariam (*et al*., 2020) STB has the highest disease incidence and severity in higher plant populations, whereas lower plant populations have a lower incidence and severity. Similarly, high weed density causes the most disease incidence and severity of STB when compared to low weed density.

Low STB incidence and severity had a higher likelihood of being linked to a previous crop of legume, barley, or tef than wheat (Hailemariam *et al*. 2020).Wheat, tef, barley, and legumes are among the crops that showed diversity in STB. In formerly wheat-grown fields, the highest disease incidence and severity are recorded impervious studies. On previously sown legumes, legumes' ability to fix nitrogen; as nitrogen levels rise, diseases can worsen; on cambisol soil and poorly maintained fields, this could be due to the legumes' ability to fix nitrogen. Agronomic practices also influence leaf blotch (Azanaw *et al.*, 2017).

The developments of STB on wheat are also influenced by the planting period. Early wheat planted fields had a higher disease incidence and severity than late wheat planted fields. The maximum STB mean incidence and severity are found in wheat fields seeded on red soil, while the lowest disease incidence and severity were found on black soil (Hailemariam *et al*., 2020).

7. MANAGEMENT OF *SEPTORIA TRITICI* BLOTCH OF WHEAT IN ETHIOPIAN PERSPECTIVE

Under Ethiopian conditions, effective and long-term disease management has yet to be accomplished (Tadesse *et al.*, 2020). To control STB in wheat fields, a variety of disease management strategies are advised. The first of these is cultural management strategies aimed at lowering inoculum pressure. Another STB management approach has been tested: bio-control. Pseudomonads have been studied as bio control agents (Ponomarkeno *et al*., 2011). To address STB, fungicides with diverse modes of action have been proposed, but their usage in Ethiopia has been limited, primarily due to cost. The most feasible means of managing STB is likely to be breeding for resistance (Teklay *et al*., 2015).

Genetic resistance remains the first line of defense against this foliar disease, especially in developing countries for resource poor farmers, and is the most environmentally friendly and profitable strategy for farmers (Teklay *et al*., 2015). However, in Ethiopia most of the high-yielding wheat cultivars grown today are susceptible to STB and there are no varieties that are fully resistant. All commercial and candidate wheat varieties are affected by the disease at varying intensity (Said and Hussien, 2016).

In the Response of Wheat Genotypes to STB in Tigray, Ethiopia, Teklay *et al.* (2015) evaluated bread wheat lines, commercial and candidate bread and durum varieties, and found that none of the genotypes are resistant. They also revealed that the majority of wheat genotypes (75.5%) were susceptible to the Disease and are classed as susceptible to extremely susceptible infections response. Therefore, majority of today's high-yielding wheat cultivars in the country are susceptible to STB, and none are totally resistant. STB impacted all commercial and candidate wheat types to varying degrees.

Although several sources of resistance have been identified, breeding for resistance has not always been successful in protecting wheat from the disease's harmful effects, as resistance expression is frequently linked to morphological features. Furthermore, wheat cultivars that are resistant in one region of the world may be susceptible in another. Even within a country, differences in pathogen virulence have been documented, which may be linked to fungal genetic heterogeneity (McDonald *et al.*, 2016). This is preventing the development of wheat varieties with a broad range of resistance. If a trait has a large cost, such as reduced yield, which is the most important aim for many wheat breeders, selection for partial resistance to STB may be limited.

STB resistance genes have been found and labeled thus far, but when compared to yellow rust, leaf rust, stem rust, and powdery mildew, which have 73, 89, 61, and 95 mapped resistance genes, respectively, this number is small. The hunt for resistance sources in previously unexploited genetic material could hasten the field implementation of STB genetic resistance. Landraces of Ethiopian durum wheat are a valuable source of such variation (Kidane *et al*., 2017). The variation in cultivar harshness is slightly greater in durum wheat than in bread wheat. They believe that 'gene pyramiding' would be effective in breeding for disease resistance and minimizing the gap between potential and actual yields (Teklay et *al.*, 2015).

Chemical spraying and planting fungicide treated seeds are some of the method to control Septoria severity in wheat. However, it is important to correctly identify STB before spraying with a fungicide as nutritional disorders such as aluminium toxicity or zinc deficiency can be confused with STB disease. According to Tadesse *et al*, (2020) STB incidence and severity are significantly reduced by the application of fungicides across Varieties but fungicide-variety combinations had differential effects on disease development. Fungicides frequency plays good role in managing the disease on partially resistant varieties. They indicate that highest disease incidence is observed that had not sprayed, whereas the lowest disease incidence is observed in plots of that had sprayed with Tilt fungicide. This result corroborated the findings of Said and Hussein, (2016), who found the highest STB incidence value in unsprayed plots of each variety.

Although complete controls of STB development are not achieved, and the extent of control differed between types, spraying Tilt fungicide greatly lowered the severity level in all varieties. According to Tadesse *et al.,* 2020 disease severity reaches 97 percent in sensitive varieties in unsprayed plots of variety Kekeba at holeta and 85 percent at Kulumsa. This suggests that the amount of fungicide applied or STB varietal resistance has a significant impact on disease progression. They agreed with (Ponomarenko *et al*., 2011) who suggests that susceptibility of the wheat cultivar and amount of disease, in particular, influence fungicide usages. Timing sprays to periods when the pathogen is most likely to be active will yield the greatest economic return on effort. In comparison to untreated plots/fields, fungicide applications considerably reduced STB severity. The key to circumventing the expense and limits of fungicide treatments is to find, produce, and use resistant wheat genetic material.

According to reports, the increased use of fungicides in the combating against this disease has resulted in a significant percentage of fungal strains developing resistance to fungicides such as strobilurin (Qo inhibitor, QoI azoles, triazole, and succinate dehydrogenase inhibitors (SDHIs) (Cools and Fraaije, 2013). Furthermore, using fungicides to manage STB is costly, inaccessible, and prohibitive for resource-poor small-holder farmers, like as those in Ethiopia, and is not environmentally safe (Kosina *et al.,* 2007).

STB incidence and severity can be reduced by cultural management. Alternatives to STB disease control include crop rotation, appropriate fertilizer, optimal sowing rates, and planting dates. Rotation to non-hosts, as well as sanitation obtained through thorough plowing of agricultural trash, can reduce the number of inoculums available to start a new disease cycle. Some cultural techniques for reducing STB severity include late early planting of early flowering and vulnerable cultivars, and eliminating stubble by grazing or cultivation. However, in light soil places where stubble must be retained to avoid erosion, this is not possible (Berraies *et al.,* 2013).

The development and deployment of resistance types, as well as periodic investigations of pathogen diversity, should be prioritized in order to ensure the long-term sustainability of wheat production. As a result, breeding for STB resistance should be prioritized. Furthermore, disease management strategies that are appropriate for small-scale farmers, who are the countries primary wheat growers, are critical (Azanaw *et al*., 2017). As a result, it's critical to devote more resources to developing various STB management measures, such as breeding and screening for STB resistance varieties, as well as variety-fungicide important. In general integrated disease management strategies including genetic resistance (resistant varieties), crop rotation, appropriate fertilizer and fungicide applications, proper seeding rates and dates would be consider to control STB disease (Berraies *et al*., 2013).

8. CONCLUSION

Wheat is the world's most extensively grown cereal crop and Ethiopia's most important major crop. Ethiopia's average wheat crop yield is lower than the global average, despite its wider production coverage and various uses. The most serious wheat fungal disease, STB, lowered production by up to 82 percent's. For millions of Ethiopian households, agriculture in general and cereals in particular constitute a source of income. Bread wheat (*Triticum aestivum L.*) and durum wheat (*Triticum turgidumssp. durum L.)* are both widely grown for food, feed, and for income. STB is widely distributed and exhibits a wide range of diversity among the country's wheat-growing regions. It is a severe wheat disease that affects all wheat-growing regions in Ethiopia. With increasing occurrence and severity in all wheat-growing areas, it has become one of the country's most damaging wheat diseases. The spread of disease in Ethiopia is encouraged by favorable weather conditions, unavailability of fungicides and absence of complete resistant genotypes. Infection levels are high in almost every research location and throughout the study year. The majority of Ethiopia's high-yielding wheat cultivars are now susceptible to STB, and there are no completely resistant varieties. The growth of STB is influenced by environmental variables, growing practices and reactions. As a result, these considerations must be taken into account while developing STB management strategies. To control STB disease, standard integrated disease management measures would include genetic resistance (resistant cultivars), crop rotation, suitable fertilizer and fungicide sprays, and optimal sowing rates and dates.

Conflict of Interest

The author declared that no conflict of interest.

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