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Yield Loss Assessment of wheat Septoria Leaf Blotch (*Zymoseptoria tritici*) Disease in Central Highland Parts of Ethiopia

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Abstract: *Zymoseptoria tritici* Blotch or Septoria Leaf Blotch (ZTB or SLB) is one of the most devastating wheat diseases worldwide and causes significant loss in production. It is known to suffer the greatest losses from disease attacks. Among diseases rust and SLB are one of the most economical. In Ethiopia yield loss study on wheat SLB was very old and scanty. This study is designed to update yield loss assessment data for wheat SLB disease. In this study, 3 treatments were used with a completely randomized block design (RCBD) with 3 replications including the control. The combined analysis of variance (ANOVA) results for the AUDPC and grain yield shows significant differences (P<0.05) among treatments.As compared to the unsprayed (control) plot both fungicides significantly controlled the disease at both the early and late stages of the crop. The lowest AUDPC (1971.67) was recorded on fungicide Tilt sprayed treatment followed by Zahysnyk (1995.0). The unsprayed (control orwater sprayed) treatment had the highest value of AUDPC (2259.837). The highest mean grain yield (6.8 t/ha) from the fungicide Zahysnyk was followed by the standard fungicide Tilt which gave (5.5 t/ha) whereas the unsprayed (control or water sprayed) treatment gave 3.1 t/ha. Thus the performance of the fungicide subjected to yield assessment on septoria leaf blotch management, Zahysnyk deserves to be considered as an alternate fungicide to the widely used fungicide Tilt in the country.The highest levels of yield loss 54.41 % occurred in the unsprayed plots of cultivar Pavan-76 as compared to the best protected plots sprayed with Zahysnyk fungicide. Generally, all disease and yield parameters indicate that among the two fungicides spray; Zahysnyk was the most effective followed by Tilt sprayed plots as compared to unsprayed plots.

Key words: Assessment · Septoria Leaf Blotch · Wheat · Yield Loss · *Zymoseptoria*

INTRODUCTION

Wheat (*Triticum* spp.) is considered among the most commonly cultivated cereal crops with over 766.4 million metric tons harvested each year [1]. Although the crop is widely cultivated at altitudes ranging from 1500 to 3000 m.a.s.l, in Ethiopia, the most suitable area falls between 1700 and 2800 m.a.s.l [2]. Bread wheat (*Triticum aestivum* L.) accounts for approximately of 20% of the total consumed human food calories and affords the most stable food for 40% of the human population [3]. Despite wheat yield and production increases, the average grain yield is still low (3.1 t/ha) and highly variable [2]. Despite its importance as a food and industrial crop, wheat production and productivity around the globe are hampered by a number of factors including biotic and abiotic stresses as well as low adoption of new agricultural technologies [4]. Of the biotic stresses, diseases caused by fungi are the most important factors constraining wheat production. Yellow rust (*Puccinia striiformis f. sp. tritici*), stem rust (*P. graminis f.sp. tritici*), leaf rust (*P. triticina*) and Septoria diseases especially *Zymoseptoria tritici* blotch or septoria leaf blotch (ZTB or SLB) are prevalent throughout the country [5]. Generally, these pathogens are restricted to wheat but can occur to a small extent in other cereals and grasses. The combination of mild temperatures with high humidity in areas, where susceptible wheat varieties are grown on large scale, creates the perfect conditions for the foliar wheat diseases to spread rapidly. Range of disease

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management options are recommended to control wheat foliar diseases in wheat fields. Among these, cultural management options designed to reduce inoculum pressure are the first one. These include rotation to non-hosts, field sanitation by deep plowing of crop debris in order to decrease the amount of inoculum available to initiate a new disease cycle. This may be less effective on a field basis due to long-distance dispersal of ascospores, but may be helpful if coordinated within a region. Fungicides of various modes of actions have been recommended to manage diseases in Ethiopia [6]. Several sources of resistance have been reported but breeding for resistance has not always been successful in protecting wheat from the damaging effects of the disease; as expression of resistance is often correlated with morphological traits [7]. Moreover, wheat cultivars resistant in one part of the world may display susceptibility elsewhere. Even within a country, a difference observed in pathogen virulence that may be associated with fungal genetic variability [7] is hindering the development of wheat varieties with broad spectrum of resistance. Resistance in wheat could be durable if the type of resistance in the variety is partial, which is polygenic, or non-specific to particular pathogen genotypes. Selection for partial resistance to wheat foliar diseases may be restricted if that trait has a significant cost, for example reduced yield, which is the most important target for many wheat breeders. The crop contributed a great deal to the country as source of food and income but it is continuously ravaged by diseases and other biotic constraints. Wheat foliar disease such as Stem rust, Yellow rust and *Zymoseptoria tritici* blotch (ZTB or SLB) are the major diseases of wheat around the world and across wheat growing regions of Ethiopia. The diseases occurs almost in all wheat growing places but its intensity varies from place to place due to variability in weather conditions, differential responses of wheat varieties to the disease and as a result of variations in crop management practices [5]. Overall wheat foliar diseases (STB, FHB and wheat rusts) remained an important constraint to wheat production all over the world including in Ethiopia. *Zymoseptoria tritici* blotch (ZTB/SLB), is among the most devastating foliar diseases of wheat Fones and Gurr [8]. It is becoming the major bottleneck to wheat production throughout the world including Ethiopia. Resistance breeding is currently seen as the best strategy, durable, economical and environmentally friendly method to control the disease [9].Supporting breeding program by alternative option such spraying fungicide is very crucial to boost production and productivity of wheat. Yield losses due to the disease are attributed to grain loss. In Ethiopia, the disease occurs throughout the major wheat production areas and is difficult to produce the crop during the main rainy season without chemical protection. In Ethiopia yield loss study on wheat SLB was very old and scanty. Due to this reason we have very eager to study yield loss assessment for this economically important disease. So our objective was to study yield loss assessment for this economically important disease of wheat.

MATERIALS AND METHODS

Description of Study Areas: The experiment was conducted under rainfed conditionat Holetta Agricultural Research Centeron the farmand Shenoon two farmers' field, during the main cropping season of 2021/2022. Holetta Agricultural Research Center islocated at 9°00'N, 38°30'Eatanaltitude of 2400 meters above sealevel (m.a.s.l.) which is hot spot for Septoria tritici blotch. It is 29 km away from Addis Ababa on the road to Ambo. And characterized with the average annual rainfall of the ranges from 0.00-304.1mm and the rainy season is from June to October, with the maximum and minimum annual mean temperatures are 23.91°C and 6.75°C, respectively, with an average of 15.33°C. The dominant soil type is clay soil (luvisols) [10].

Experimental Materials and Procedures: Wheat variety (Pavon-76) which is the most susceptible for septoria leaf blotch was used for this experiment. Fungicide Tilt was previously recommended for septoria leaf blotch control (as positive) and unsprayed plot (as negative), were used as control and Zahysnyk was used as treatment. Fungicides application was started as soon as the disease symptom was observed on the susceptible variety.

Treatments and Experimental Design: In this experiment a total of 3 treatments were used in a randomized complete block design (RCBD) with3 replications.

Experimental Field Management: The Pavon-76variety was used to plant at plot size of 10 m X 10 m = 100 m^2plots with three locations at HARC and on two farmers' field at Sheno. The systemic fungicide Tilt (as a standard check), Zahysnyk (fungicide as treatment) and water spray used as (control plot). Application of fungicides was started when disease symptoms appeared, Subsequent spray was made at 14 days intervals at rates of 0.5 lt ha^{-1}, using 200lt of water ha^{-1}.

Data Collected: Disease Severity of *Zymoseptoria tritici* blotch were recorded by using the double-digit scale (00-99) at 14 days interval and Area under Disease Progress Curve (AUDPC) values were calculated for each plot. Thousand Kernel weight (TKW) (g), Hectoliter weight (HLW) (Kg/hL), Grain yield (GY) and Relative Yield Loss (RYL) were recorded from each plot. The major parameter, disease severity, AUDPC and grain yield were considered to make the comparison with the standard and the control treatment that help to measure the efficacy of the fungicide.

Area under Disease Progress Curve (AUDPC): was calculated for each treatment using the formula [11].

$$AUDPC = \sum [0.5(Xi + 1 + Xi) (ti+1-ti)]$$

where **Xi** is the cumulative disease severity expressed as a proportion at the **i^th^** observation, ti is the time (days after planting) at the **i^th^** observation and n is the total number of observations. Since Septoria leaf blotch severity was expressed in percent and time (t) in days, AUDPC values were expressed in unit percent-days [12].

Thousand Kernel Weight (TKW) (g): One thousand grains selected at random were weighed in grams for each experimental unit.

Hectoliter Weight (HLW) (Kg/hL): - Grain weight of one-liter volume (random sample) was estimated for each experimental unit by following standard procedure [13] and the result were converted to Kg/hL. The moisture content was adjusted at 12.5%.

Grain Yield (GY) (Tones): Grain yield in g/plot at 12.5% moisture content were recorded and converted to t/hectare.

Relative Yield Loss (RYL): The percent yield loss was computed using the formula [14].

$$\%RYL = \frac{YP - YT}{YP} * 100\%$$

where
RYL = Relative percent loss
YP = Yield from the maximum protected plot,
YT = Yield from other treated plots.

Data Analysis: Data were subjected to analysis of variance (ANOVA) to determine the treatment effects [15]. Duncan's Multiple Range Test (DMRT) at 5% probability level was used for mean separation. All the data analyses were done using the Statistical Analysis System (SAS) Version 9.3 [16].

RESULTS AND DISCUSSION

SLB severity did not vary significantly across treatments (Table 1). At last assessment date, the unsprayed plot of Pavan-76 variety showed higher (90.7%) disease severity followed by Zahysnyk and Tilt treatments 82.3%, 81.3% respectively. The combined analysis of variance (ANOVA) results for AUDPC and yield indicate that significant differences ($P<0.05$) among treatments (Table 1). There is no significant difference among the candidate fungicide (Zahysnyk) and standard check fungicide (Tilt) for all parameters. The highest AUDPC was recorded on the control plots (2259.83) and the lowest AUDPC was recorded on standard check (1971.67) which was not significant different with the candidate fungicide (1995.0).The candidate fungicide significantly controlled the disease as compared to the unsprayed control plot.

Mean yield significantly differ among treatments. The highest mean yield (6.8. t ha-1) was obtained from fungicide Zahysnyk followed by the standard fungicide which gave (5.5 t ha^{-1}) whereas the control treatment gave 3.1 t ha^{-1}. The candidate fungicide and the standard check fungicide were not statistically significant difference among them whereas significant difference with the control treatments. However, Zahysnyk had 23.6 % yield advantage over the standard fungicide Tilt.

Similarly, Wheat variety Alidoro sprayed with tilt fungicide had the lowest (1148%-days) [17]. This agrees with that of Takele *et al*. and Said and Hussein [18, 19], who reported maximum AUDPC values from unsprayed plots.

This finding is in agreement with Yitagesu *et al*. [17], the highest yield (6.5 -6.67t/ha) was recorded on Alidoro variety and grain yield from unsprayed was low. Takele *et al*. [18] also reported lower qualitative and quantitative grain yield from untreated plots in comparison with treated one.

Thus based on the performance of the fungicide subjected to yield loss assessment on the Zymos*eptoriatritici* blotch management and yield, Zahysnyk deserve to be considered as an alternate fungicide to the widely used fungicide Tilt in the country.

Table 1: Yield losses of wheat variety (Pavan-76) due to Septoria Leaf Blotch (SLB) at Holetta Agricultural research Center and Sheno farmers' field in Oromia region in 2021 and 2022.

Treatments	Last Severity	AUDPC	HLW	TKW	YLD (t/ha)	% RYL
Zahysnyk	82.3[a]	1995.0[b]	79.5[a]	33.3[a]	6.8[a]	0
Tilt	81.3[a]	1971.67[b]	79.2[a]	34.9[a]	5.5[a]	19.12
Control	90.7[a]	2259.83[a]	73.4[a]	28.3[a]	3.1[b]	54.41
Mean	84.78	2075.5	77.4	32.2	5.1	
CV %	7.25	3.29	7.6	11.5	17.6	
LSD 0.05	13.9	81.3	13.3	8.4	2.0	

Means in a column followed by the same letters are not significantly different according to LSD at 5% probability level.

Relative Yield Losses: The yield loss that was incurred for each of the fungicide application were calculated relative to the yield of maximum protected plots i.e. Zahysnyks prayed plots with 6.8 t/ha for variety Pavan-76 (Table 1).

The highest levels of yield loss 54.41 % occurred in the unsprayed plots of cultivar Pavan-76 as compared to the best protected plots sprayed with Zahysnyk fungicide. Hence, the second highest percent yield loss (19.12 %) was recorded from plots sprayed with Tilt as compared to Zahysnyk sprayed plots.

The result agrees with the findings of Said and Hussein [19] in which STB was reported causing grain yield loss of up to 41%. That susceptible genotypes showed higher yield losses as compared to resistant genotypes. Yield can be severely reduced if disease pressure is high and yield losses of 30 -50% have been reported in wheat [20, 21]. The result also confirm the findings of Goodwin *et al*. [21] in which wheat grain yield losses of 30-50% were attributed to SLB. The reports shows that the disease is causing 42% economic loss annually in Ethiopia [18,19].The result is in line with report of Yitagesu *et al*. [17], at Holetta, maximum relative grain yield loss was 54.2% and this was recorded on unsprayed plots of the variety Madawalabu. On Kekeba variety, grain yield loss of about 36% was recorded when STB was allowed to develop naturally. For Alidoro variety, grain yield reduction of about 19% was recorded on unsprayed plots.

Severe yield losses can occur in crops when the top two or three leaves (flag, second and third leaf of wheat plants) become infected [22]. Therefore, overall use of resistant cultivars would potentially reduce losses due to septoria leaf blotch, reduce the cost of crop protection and reduce the risks of fungicide resistance strain appearance in wheat production. Generally all disease and yield parameter indicate that among the two fungicides spray; Zahysnyk was the most effective followed by Tilt sprayed plots as compared to unsprayed plots.

CONCLUSION AND RECOMMENDATION

Septoria Leaf Blotch is one of the most devastating diseases of wheat worldwide and cause significant loss in production. In Ethiopia yield loss study on wheat septoria leaf blotch was very old and scanty. Due to this reason we have very eager to study yield loss assessment for this economically important disease of wheat. So our objective was to study yield loss assessment for this economically important disease of wheat. The experiment was conducted under rain fed condition at Holetta Agricultural Research Center and on farm in Sheno during 2021/2022 main cropping season. The experiment had a total of 3 treatments were used in a randomized complete block design (RCBD) with 3 replications including the control. The combined analysis of variance (ANOVA) results for AUDPC and grain yield shows significant differences ($P<0.05$) among treatments. The highest mean grain yield (6.8 t/ha) was obtained from fungicide Zahysnyk followed by the standard fungicide (Tilt) which gave (5.5 t/ha) whereas the control treatment gave 3.1 t /ha. Based on the performance of the fungicide subjected to yield loss assessment on the septoria leaf blotch management, Zahysnyk deserve to be considered as an alternate fungicide to the widely used fungicide Tilt in the country. The highest levels of yield loss 54.41 % occurred in the unsprayed plots of cultivar Pavan-76 as compared to the best protected plots sprayed with Zahysnyk fungicide. Generally all disease and yield parameter indicate that among the four fungicides spray; Zahysnyk was the most effective followed by Tilt sprayed plots as compared to unsprayed plots.

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