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ORIGINAL ARTICLE

Survey of wheat *Fusarium* head blight disease in South Eastern Ethiopia

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Wheat foliar mainly rusts, *Fusarium* head blight and bacterial diseases are economically important restraints to wheat production in Ethiopia particularly in Arsi and West Arsi potential wheat growing areas. FHB is amongst the greatest epidemic fungal diseases of wheat and other small cereal crops due to its influence on yield and quality, but mainly due to its possibility to produce mycotoxin DON, which are risky to human beings and animals. In 2022 late meher season, monitoring was conducted to determine distribution and extent of major foliar wheat diseases. The survey result showed that *Fusarium* head blight is the most economically important wheat production constraints in the surveyed areas. Weather is the main variable determinant factor in FHB epidemics. The prevalence of *Fusarium* head blight at Arsi zone showed 42.8 to 100 percent varied with production districts and 100 percent on all wheat growing areas of West Arsi zone. Over all assessed fields maximum disease severities were recorded and wheat fields infected by *Fusarium* head blight at flowering to dough wheat growth stage with higher epidemics on all assessed cultivars and on almost 30 percent in Arsi and 50 percent severities in West Arsi zones on popular varieties.

Keywords: Wheat, Variety, *Fusarium* head blight, Severity, Prevalence, Incidence.

Introduction

Wheat is the most important cereal crop in Ethiopia, ranks 3rd in the area coverage after teff and maize and 2nd in production potential next to maize. The national average yield is 3.05 and 4.0 t ha^{-1} under rain fed and irrigated conditions respectively which is cultivated below the average yield of 3.5 t ha^{-1} and potential yield of 7 and 8 tha^{-1} in rain fed and irrigation respectively (Grote, U., et al., 2021; CSA, 2021). This productivity limitation is attributed to several factors, including increased intensity of biotic (diseases, weeds, and insect pests) and abiotic stresses (drought and heat) and slow rate in adoption of new agricultural technologies (Netsanet, B., et al., 2020). Among these production constraints, diseases play a substantial influence on yield reductions, which has an impact on the crop's economic value. Of them, fungal diseases such as rusts (stem/black, yellow/stripe and brown/leaf), *Fusarium* head blight (FHB) and Septoria blotch, are the major diseases on wheat.

Wheat head blight (scab) is a floral disease caused by different species, especially *F. graminearum* and *F. culmorum* which infection occurs when ascospore will releases with favorable conditions of temperature around 15°C to 30°C, relative humidity is more than 90% and at least rainfall is 5 mm for prolonged periods (48-72hrs) that affects FHB development and mycotoxin accumulation before, during and after anthesis (McMullen, M., et al., 2012; Maria, B., et al., 2019).

In Ethiopia FHB was not considered as a major problem for many years, but the last years it has increased its frequency, intensity, epidemics and become one of the most damaging diseases of wheat during wet, warm and high rainfall periods from anthesis to the soft dough growing stage and epidemics are primarily initiated by initial inoculum from infected crop residue (Kebede, M., et al.,

2021). Inoculum density, host resistance level and cultural practices like mono cropping of wheat after barley in a rotation system significantly influences its incidence and severity (Kriss, A.B., et al., 2010). It also becomes a concern due to multiple factors, including the adoption of zero, minimum or conservation tillage practices and expansion of maize production which initiates incidence of the pathogen on epidemic scale and enhance survival, dynamics of the pathogen population and climate variability (Chakraborty, S., et al., 2011; Scala, V., et al., 2016).

FHB can cause yield losses up to 74% in small grain cereals, but more importantly, grain from damaged crops may be less palatable to stock than healthy grain. In fact, every year infection of wheat by the *Fusarium graminearum* results in losses of 28 million metric tons of wheat grain, valued at $5.6 billion (Serge, S., et al., 2019; Gang, W., et al., 2020). Wheat yield loss due FHB results mainly from bleaching of some or all of the spikelet's appear on wheat Leaf, head, grain and peduncle, reduction in kernel size, reduced seed weight, discoloration and shriveled grain, with a floury interior and contamination with mycotoxins, such as deoxynivalenol and reduction in seed quality (Wegulo, S.N., et al., 2015). In Ethiopia, FHB of wheat has conducted in some wheat growing areas; revealed that the disease is emerging as the major wheat production constraint with different degree of distribution and severity (Misgana, M., Yesuf, E., 2016). Therefore this work was conducted to determine the distribution and prevalence of FHB in Arsi and West Arsi Zones of south eastern Ethiopia.

Materials and Methods

The study was carried out in major potential wheat growing areas of Arsi and West Arsi zones of south eastern Ethiopia from 21st to 25 September 2022 main cropping season. Arsi zone is located 7.2990412 to 8.1424752 N latitude, 39.1529498 to 39.3191193 E longitude and an altitude range of 2105 to 2967 meter a.s.l whereas, West Arsi zone was located 6.9826638 to 7.2838827 N latitude, 38.9571223 to 39.4417384 E longitude and an altitude range of 2367 to 2612 meter a.s.l. Purposive multistage sampling strategy to choice wheat growing districts and random sampling method to select wheat field was applied. Global positioning system (GPS) reading was taken by ODK in each sampling point and coordinates were used to generate maps using the geographical information system (GIS) software Arc Map 10.3.

Disease assessment

Samples were collected along the diagonal of the field by placing 20 cm × 20 cm quadrat randomly in four spots per field. Each Survey was made early milk to hard-dough stage of the crop during which FHB disease symptoms were clearly witnessed in wheat fields. Disease (incidence, severity and prevalence) data were collected according to Miedaner, et al., (1996).

Disease Incidence (DI) was determined as proportion of infected plants showed blighted symptoms in the field.

FHB incidence (%)=(number infected spikes within the quadrate/ Total number of assessed spikes within the quadrate) × 100

Disease Severity (DS) was determined as the proportion of bleached spikes with in randomly thrown quadrants. In each fields severity was rated on scale of 0 to 9, where: 1=no symptoms, 2=<5%, 3=5-15%, 4=16-25%, 5=26-45%, 6=46-65%, 7=66-85%, 8=86-95%, 9=96-100% Miedaner, et al., (1996).

FHB field severity (%)=(Sum of all scores including zero's within the quadrate/Total number assessed spikes within the quadrate)

Severity scores were converted to percent of disease severity index, (PSI) using the formula suggested by Wheeler and Kumar, et al., (2011).

FHB index (%)=[FHB incidence (%) x FHB field severity (%)]/100

Results and Discussion

FHB was found in all of the assessed wheat fields of Arsi and West Arsi zones of South Eastern Ethiopia. The results indicated that 100% of surveyed fields were infected with FHB. The highest disease prevalence was (100%) was recorded in the fields of West Arsi zone districts of Kofele Dodala and Gedeb Assasa, while the lowest prevalence was (85.7%) was recorded in Arsi zone districts of Lemu Bilibilo (Table 1). The highest FHB mean incidence (95.5%) was recorded in Kofele, Dodola and Gedeb Assasa compared to

other districts and lowest disease incidence was recorded in Arsi zone districts of Lemu Bilibilo and Dixsis. The highest mean severity of FHB was recoded on West Arsi zone districts than Arsi zone districts (Table) whereas lowest FHB disease severity was recorded in Arsi zone districts of lemu Bilbilo and Dixsis (Table 1).

FHB incidence, Severity and prevalence varied among the assessed wheat varieties in all assessed areas. The varieties kubsa, Deka, Dursa, and Wane had highest severities and incidence while low severity and incidence of FHB was recorded on Hidassie varieties during the survey (Table 2).

FHB in wheat was extensively distributed and occurred at epidemic level with hot and humid agro ecologies in major wheat growing areas of Arsi and West Arsi zones. The disease is major limiting factor to wheat production in the country as indicated by Tadesse, et al., (2019), kebede, et al., (2021) and Muluken, et al., (2022), who reported that FHB is the major biotic limiting constraint of wheat production in eastern Africa and widely distributed with 100% incidence in south eastern Ethiopia. FHB is more common in wheat regions with hot and humid weather, especially if rain fall is significant and spike wetness duration is higher than 48 hours. Attempts of Kriss, et al., (2010) described that environmental variables was significantly affect the FHB disease intensity.

In our survey study FHB prevalence, incidence and severity varied among zonal districts. The disease was majorly found at epidemic level at West Arsi zonal districts with 100% prevalence than Arsi zone. According to attempts of Wagacha, et al., (2016), Njeru, et al., (2016), Misgana and Yesuf (2016) and Abdisa and Bekele (2020) the variation in FHB disease intensity throughout the different agro ecological zones could be related to variations in environmental conditions which have an impact on aspects of FHB disease epidemiology. The assessment results also revealed that the susceptibility and disease intensity level of wheat varieties have different disease response in the assessed fields. In agreement in this findings, Land schoot, et al., (2012), Bekele and Karr (1997), Salas and Macky (2004) reported that susceptibility of wheat genotypes to FHB critically depends on weather conditions facilitating the infection and altered infection by FHB pathogen species suggesting that use of resistant cultivars may reduce epidemics of the pathogen.

Table 1. Prevalence and Severity of FHB in wheat producing areas of West Arsi and Arsi.

Surveyed Zone	District	FHB Incidence	FHB Severity	FHB Index	FHB Prevalence
	Kofele	95	40	38	100
West Arsi	Dodola	85	32.5	27.6	100
	Gedeb Asasa	23.3	6	1.4	100
	Zonal mean	67.8	26.2	22.3	100
	LemuandBilbilo	7.1	2.1	0.15	42.8
	Digalu andTijo	31.6	11	3.47	83.3
	Tiyo	30	15.3	4.6	87.5
Arsi	Lode Hitosa	13.3	3.3	0.44	66.6
	Hitosa	15	4	0.6	100
	Dixsis	0	0	0	0
	Arsi Robe	28	7	1.96	100
	Zonal mean	17.9	6.09	1.6	85.7

Wheat yield losses from bleaching of spikelets, reduction in kernel size, reduced seed weight, discoloration and shriveled grain and reduction in seed quality could be the effect of FHB (Fig. 1 and Fig. 2).

Fig. 1. FHB Infected spickilets at West Arsi Fig. 2 shirivilied wheat grain by FHB.

Table 2. Response of wheat varieties to FHB at surved fields.

Surveyed Zone	Variety	No. of fields	FHB Incidence	FHB Severity
	Kubsa	4	0->40	0-50
	Deka	2	0->40	0-10
West Arsi	Dursa	1	>40	50
	Hidassie	1	20	5
	Wane	1	>40	50
	Unknown	1	>40	40
	Hidassie	4	0-40	0-10
	Lemu	1	0	0
	Danda'a	4	0->40	0-20
Arsi	Wane	2	0-40	0-20
	Shaki	1	20	5
	Israel	1	0	0
	Kubsa	3	0-20	0-5
	Deka	3	0->40	0-10
	Digalu	1	20	2
	Unknown	8	0->40	0-30

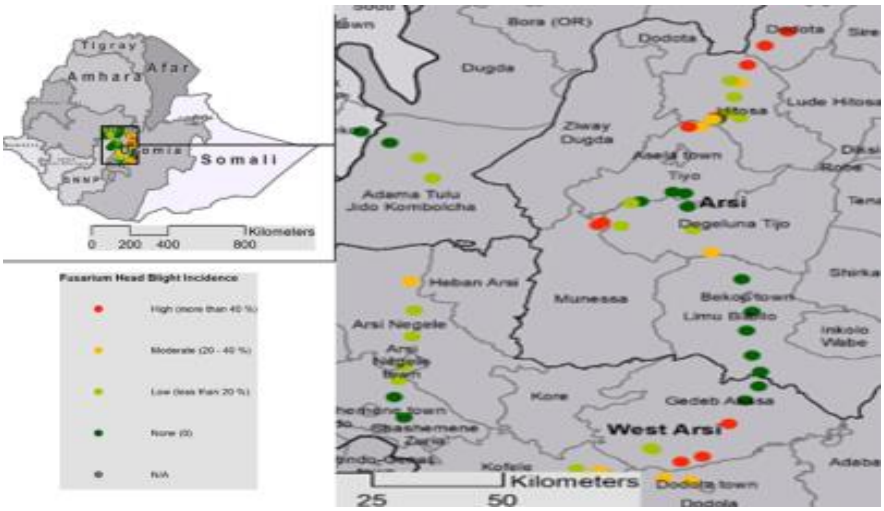

Fig. 2. Map of distribution and prevalence of *Fusarium* head blight disease at Arsi and West Arsi zones.

Conclusion

Wheat *Fusarium* head blight pathogen is widespread and major constraint in potential wheat growing areas of Ethiopia especially in Arsi and west Arsi zones. This suggests that FHB pathogen epidemics could be cause severe threat to increase wheat production and productivity challenging effort for food security. The disease prevalence, incidence and severity varied with across the districts and wheat cultivars. *Fusarium* head blight infected wheat fields caused by bleaching of spikelets, reduction in kernel size, reduced seed weight, discoloration and shriveled grain and reduction in seed quality and significant effect on grain yield losses. More field based effective management strategies will require in integration of all available integrated management tactics of crop rotation, improved varieties, chemical control, diversifying planting times and weather based early warning system to incorporated in the future research and mitigate the impact of *Fusarium* head blight on wheat production.

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Conflict of Interest

The Authors declare no conflict of interest.

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