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ORIGINAL ARTICLE

# Survey of major wheat diseases in wheat producing areas of South East Ethiopia

## A.A. Zerihun<sup>\*</sup>, T.N. Gure, G.M. Abebel, D.K. Hmariam

Kulumsa Agricultural Research Center, Ethiopian Institute of Agricultural Research, P.O.Box. 489 Asella

Ethiopia

\*Corresponding author E-mail: alemuayele81@gmail.com

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The Ethiopian highlands are suitable environment for wheat production and conducive for perpetuating of several wheat diseases including rusts. In 2022 during belg, early and late meher seasons, monitoring was conducted to determine distribution and extent of major wheat diseases. The survey result showed that yellow rust, fusarium head blight followed bacterial black chaff and stem rust diseases were the most economically important wheat production limiting constraints in the surveyed areas respectively. The dominant wheat cultivars grown in the assessed fields were Hidassie, Lemmu, Danda'a, Wane, Shaki, Israel, Kubsa, Deka, Digalu and unknown with coverage frequency of 13%, 3%, 11%, 8%, 3%, 3%, 19%, 13%, 3%, 24% respectively. Over all assessed fields maximum disease severities were recorded and wheat fields were infected by yellow rust at tillering to heading; bacterial black chaff during booting to dough growth stage and fusarium head blight at flowering to dough wheat growth stage with higher epidemics on popular varieties. Therefore, wheat foliar mainly rusts, fusarium head blight and bacterial diseases are economically important constraints to wheat production currently in Ethiopia particularly in Arsi and West Arsi potential wheat growing areas. The wheat cultivars that grown during growing seasons was susceptible to yellow rust that needs frequent application and replacement of recently released wheat cultivars besides future interventions to be taken to reduce its epidemics.

Keywords: Yellow rust, Fusarium head blight, Bacterial black chaff, Severity, Epidemics, Incidence.

### Introduction

Globally, wheat is the most important food security cereal crop which is cultivated on 216 million hectors in 766 million metric tons (Grot, et al., 2021; CSA, 2021). Currently in Ethiopia wheat production is expanding in extreme highlands to low lands which stands 6.9 million tons on 2.1 million hectors during belg, meher and irrigated wheat with productivity of 3.05 and 4 tons per hector under rain-fed and irrigation respectively (Wuletaw, et al., 2022).

Currently, wheat production is faced by biotic and abiotic challenges that limits its productivity below expected country's potential yield. Among the biotic factors, recurrent rust epidemics, occurrence of fusarium head blight and bacterial leaf streak are the most important bottlenecks for wheat yield loss in Ethiopia. These recurrent disease epidemics were incurred due to monoculture practice of wheat after wheat, absence of wheat free periods throughout the year that is producing belg season from March to July, mehar season from June to December and irrigated season from December to April, cultivation of susceptible and obsolete cultivars for long production years, inappropriate planting of varieties with recommended agro-ecologies with lack of varietal deployment regulation and climate change increases production cost and yield loss. The Ethiopian highlands are suitable environment for wheat area is hot spot to yellow rust which 66% is in Amhara, 27.6% in Oromia and 6.4% in other remaining regions, but 24% of wheat growing area is also prone to stem rust of which 68% in Oromia, 25% in SNNP regions and 8% in other regions. Over all 22% of

wheat potential area is prone to both stem and yellow rust of these 85% is located in south eastern Ethiopia mainly in Arsi, West Arsi and Bale Zones (Badebo, A., Abeyo, B., 2022). So genetic improvement has vital role in developing durable resistant genotypes and to avoid susceptible and obsolete varieties cultivated for long periods in production that increases chance of disease epidemics. Timely monitoring and early warning system is crucial tactic to predict the direction and severity of disease epidemic to address information to the stake holders, avail and make decision on effective fungicides in use. Hence, the assessment was accompanied with aim of determining major wheat diseases intensity and distribution in potential wheat growing area of south eastern Ethiopia.

#### Methods

The study was carried out in major wheat growing areas during belg, early meher and late meher seasons of Arsi and West Arsi zones of south eastern Ethiopia during 2022 cropping seasons. A total of seventy two wheat fields were assessed, forty six fields were assessed during the *belg*, early *meher* and late *meher* seasons from different districts of Arsi and twenty six wheat fields were assessed during early from seedling to stem elongation crop stage and late meher from early milk to hard dough growth stage of seasons from West Arsi zone following the main roads accessible routs along the field by placing randomly 50 cm by 50 cm quadrant in four spots per field. To choice wheat growing districts and to select wheat fields purposive multistage sampling strategy and random sampling methods were applied respectively. In each sampling point and global positioning system (GPS) coordinates were taken by ODK (open data kit) and stops were made by vehicle odometers at every 5-7 km interval of wheat parcel to generate maps using the geographical information system (GIS) software Arc Map 10.3 (Table 1).

Table 1. Geographical coordinates (latitude/northing, longitude/easting and altitude/elevation) of surveyed area.

Location name		Geographical Locations				
Zone	District	Latitude (Easting)	Longitude (Northing)	Altitude		
	Kofele	7.0202038-7.031515	38.9571223-38.9979014	2534-2568		
West Arsi	Dodola	6.9826638-7.0087061	39.060788-39.1540921	2413-2470		
	Adaba	7.0067949-7.0240699	39.3433441-39.4417384	2367-2451		
	Asasa	7.0381086-7.2838827	39.1576751-39.2705157	2385-2612		
	Lemu bilbilo	7.2990412-7.6934489	39.1644805-39.2708657	2454-2967		
Arsi	Digalu and Tijo	7.7811676	39.1529498	2563		
	Tiyo	8.0236981-8.0433893	39.1692391-39.1981914	2220-2260		
	Hitosa	8.0870326-8.1424752	39.2228472-39.3191193	2105-2198		

Disease (incidence, severity, prevalence and index) data and varietal response were taken accordingly. Yellow rust disease incidence was assessed by the proportion of infected plants as percentage of total number of assessed plants within quadrants, while its severity of yellow rust was scored using modified Cobb scale (Peterson, et al., 1948).

The incidence of Fusariam head blight was Fusariam head blight disease incidence (DI) was resulted by calculating the diseased plants that showed infected symptoms of the total number of assessed spikes within quadrant in the field, whereas disease severity was determined in rate scale of 0 to 9 whear: 1=no symptoms, 2=<5%severity scores, 3=5-15%, 4=16-25%, 5=26-45%, 6=46-65%, 7=66-85%, 8=86-95%, and 9=96-100% (Miedaner, et al., 1996) and severity scores were converted to percent of disease severity index using the formula recommended by wheeler and Kumer, et al., 2011.

## **Results and Discussion**

The survey covered a total of seventy two wheat fields planted with fourteen different released varieties and two unknown cultivars which were different to identify across in all assessed fields. Among, 76% of wheat fields were covered by improved varieties and the remaining 24% was covered by unidentified wheat cultivars. Accordingly, the disease prevalence and distribution was increasing in all surveyed fields. The wheat cultivars that grown during the belg season were susceptible to yellow rust that needs frequent application and replacement of recently released wheat cultivars (Table 2 and Table 3).

The most prevailing cultivars cultivated in the study areas were Hidassie (13%), Lemmu (3%), Danda'a (11%), Wane (8%), Shaki (3%), Israel (3%), Kubsa (19%), Deka (13%), Digalu (3%) and unknown (24%) with disease incidence of 20-40%, 40%, 20-40%, 40%, 40%, 20%, 40%, 60%, 20% and 40% respectively (Fig. 1). The prevalence of fusariam head blight was 100% across the inspected districts of West Arsi zone and 42 to 100% across Arsi zone districts (Fig. 2 and Table 4). This high distribution and prevalence of yellow rust and fusariam head blight as well as bacterial diseases on dominant cultivars across districts were becoming major wheat production constraint. Most of wheat cultivars grown in farmers field were infected by the disease might be previous harvested seeds are infected that causes for seedling blight and contributes for disease spread and initiates for disease epidemics (Table 4). In Ethiopia the survey results indicated that wheat yellow rust and Fusariam head blight diseases are increasing from time to time due to monoculture practice of wheat after wheat, continuous cultivation of susceptible and obsolete cultivars for long period of time and climate change that increases for appearance of new path type. Despite the fact the fusariam head blight disease and bacterial black chaff diseases were newly emerging and distributed to wide wheat production areas, majority of wheat growing stake holders including farmers didn't take any actions against the diseases because of their insufficient knowledge for newly appeared diseases (Fig. 3 and Fig. 4). This revealed that conducive environmental conditions favors for diseases epidemics during the cropping season. Bacterial disease and fusariam head blight diseases are sporadic in nature and their distribution is vastly determined by environmental factors (Parry, et al., 1995; Martinez, et al., 2012). According to Mobasser, et al., (2012) findings informal seeds sources can increase FHB level in wheat growing areas by contributing as sources of disease inoculum.

Most of the mega wheat cultivars formerly under cultivation in the assessed areas were showed susceptible to all diseases with substantial yield and quality loss. None of the grown cultivars were showed resistant to yellow rust (Table 5) and for fusariam head blight (Table 4). The findings done by Mamluk, et al., (2000) and Bekele (1990) stated that majority of wheat cultivars grown by Ethiopian farmers were susceptible to major wheat diseases.

Location	Variety	Growth stage		Yellow rust	
Location			Incidence	Severity	Reaction
Jeju	K6294A	Booting	50	10	S
Jeju	K6294A	Milky	50	10	S
Lode Hitosa	K6294A	Booting	50	20	S
Jeju	K6294A	Flowering	100	50	S
Jeju	Unknown	Booting	80	30	S
Jeju	K6294A	Booting	0	0	0
Jeju	K6294A	Flowering	5	5	MSS
Jeju	K6294A	Flowering	20	20	S

Table 2. Response of cultivars to yellow rust during Belg season survey at Arsi zone.

Table 3. Yellow rust incidence and severity of early Meher season at Arsi and West Arsi zones.

	Variety	Number of Fields Associated Fields	Yellow rust		
Zone		Number of Fields Assessed Fields	Incidence (%)	Severity	
	Unknown	10	0-20	0-10S	
West Arsi	Kubsa	5	0-20	0-10S	
	Deka	1	0	0	
	Unknown	5	0-20	0-10S	
	Deka	2	0	0	
Arsi	Hidassie	1	20	10S	
	Wane	1	0	0	
	Kubsa	1	0	0	

Surveyed Zone	District	FHB	FHB	FHB	FHB
Suiveyeu zone	District	incidence	severity	Index	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
	Lemu and Bilbilo	7.1	2.1	0.15	42.8
	Digalu and Tijo	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
	Arsi Robe	28	7	1.96	100
	Zonal mean	17.9	6.09	1.6	85.7





Fig. 1. Frequency of wheat varieties in the assessed fields.



Fig. 2. Rust distribution map of assessed fields at Arsi and West Arsi zones during early meher season.



Fig. 3. Bacterial black chaff infected wheat field at Siribo, Arsi-Ethiopia.

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		Yellow rust Incidence		Stem rust Incidence		Septoria Incidence	
	Variety						
Zone		(%)	Severity	(%)	Severity	(%)	Severity
	Kubsa	>40	20mss	0-40	0-20s	0-20	0-83
West Arsi	Deka	0-20	5mrms	0-20	0-5mss	0-20	0-81
	Dursa	0	0	0	0	0	0
	Hidassie	>40	20mss	0	0	20	0-84
	Wane	0	0	0	0	0	0
	Unkown	0-40	0-10s	0-40	0-10ms	0	0
	Hidassie	20-40	30mss	0	0	0-20	0-85
	Lemmu	>40	30s	0	0	0	0
	Danada'a	0-20	5ms	0	0	0-20	0-32
Arsi	Wane	>40	10-40s	0	0	0-40	0-53
	Shaki	>40	60s	0	0	0	0
	Israel	20	10ms	0	0	0	0
	Kubsa	20	5mss	0	0	0-20	52-83
	Deka	0-60	0-50s	0	0	0-20	0-83
	Digalu	20	10ms	0	0	0	0
	Unkown	>40	0-50s	0	0	0-40	0-64

Table 5. Rust distributions in wheat producing areas of West Arsi and Arsi during Late Meher season.



**Fig. 4.** Bacterial streak on leaf, bacterial black chaff on spike, purplish balck on pendicle photos taken from siribo Arsi during the late meher season survey.

#### Conclusion

A total of seventy two wheat fields were assessed, forty six fields were assessed during the belg, early *meher* and late *meher* season from different districts of Arsi and twenty six wheat fields were assessed from West Arsi following the main roads. The survey result revealed that assessed wheat fields were infected by yellow rust at tillering to heading by infecting wheat spike, bacterial black chaff under cool to worm season and high humidity during booting to dough growth stage at highland wheat growing fields. However, fusarium head blight under high rain fall, warm temperature and humid conditions in midlands in early stage of kernel development and flowering to dough wheat growth stage was with higher epidemics on popular varieties that causes quantitative and qualitative losses. Timely monitoring the level resistance of mega cultivars to diseases, analyzing the data, predicting the direction and rust epidemics and advocating and delivering the information to stack holders and farming communities

on integrated disease management including fungicide attentiveness and use could be addressed as key tactics to take action and minimize crop loss.

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### **Conflict of Interest**

There is no any conflict of interest legal requirements and ethical Ethiopia's guidelines of the study.

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