

# Wheat Stem Rust (*Puccinia graminis f. sp. tritici*) Disease Assessment in Arsi and West Arsi Zones, South Eastern of Ethiopia

Worku Abebe<sup>1</sup>, Temam Hussien<sup>2</sup>

<sup>1</sup>Ethiopian Institute of Agricultural Research Holeta Agricultural Research Centre, Ethiopia

<sup>2</sup>Haremaya University College of Agriculture and Natural Resources Department of Plant Protection

Corresponding Author: Worku Abebe: e-mail: [workuabebe2005@gmail.com](mailto:workuabebe2005@gmail.com)

---

**Abstract:** Wheat is the most important and widely grown cereal crop in the world. In Ethiopia, wheat is one of the most important cereal crops and is widely grown in a wide range of altitudes and agro-ecological zones. It is the main staple food of the Ethiopian population particularly in the highlands where it is produced in a large volume. Though it was the most important; its production is constrained by different biotic and abiotic constraints. Of the biotic constraints; wheat stem rust is the most destructive and widely distributed disease in the world and in Ethiopia. It is prevalent in most wheat growing areas of Ethiopia and reports indicate that most Ethiopian wheat varieties are susceptible to most of previously identified races of *Puccinia graminis f. sp. tritici* and to the newly evolved *Puccinia graminis f. sp. tritici* race Ug99 and its lineages. Thus, this frequent change of virulence in wheat stem rust pathogen population requires a continuous assessment for the appearance of new races and for the evaluation of reactions of the existing wheat varieties. Therefore, regular wheat stem rust disease survey is imperative and based on this fact a survey was conducted in four districts (Gedeb Asasa, Arsi Negele, Tiyo and Arsi Robe) of Arsi and west Arsi zones in 2008 main cropping season to assess wheat stem rust prevalence, incidence and severity as well as to evaluate the reaction of wheat varieties grown in the surveyed area. Results of the survey showed that mean prevalence of wheat stem rust disease was 100% in all surveyed districts and in each surveyed field. The highest mean of wheat stem rust disease incidence (76%) was recorded in Arsi Robe district followed by Tiyo (33.13%) and Gedeb Asasa (18.5%) whereas the lowest mean of wheat stem rust disease incidence (8%) was recorded in Arsi Negele district. Similarly the highest mean wheat stem rust disease severity (50%) was noted in Arsi Robe district followed by Tiyo (24.4%) and Gedeb Asasa (13.5%) districts while the lowest (11.2%) mean of wheat stem rust disease severity (11.2%) was recorded in Arsi Negele district. The reactions of wheat varieties grown in surveyed area were ranged from moderately susceptible to susceptible and most of them were found susceptible. Therefore, these survey results indicated the importance of replacement of susceptible varieties by resistant varieties in the surveyed area.

**Keywords:** Wheat stem rust, Disease assessment, Varietal reaction, Arsi and West Arsi zones.

---

## 1. INTRODUCTION

Wheat is the most important and widely grown cereal crop in the world occupying 17% of the world's cultivated land (Carter, 2002). Bread and durum wheat are the two principal commercial types of wheat. Bread wheat covers about 90 percent of the world wheat area and makes up 94 percent of production whereas durum wheat is less cosmopolitan in its distribution (Stubbs *et al.*, 1986).

In Ethiopia, wheat is one of the most important cereal crops and is widely grown in a wide range of altitudes and agro-ecological zones (Hailu *et al.*, 1991; Bekele *et al.*, 1999; Belay and Tanner, 1999). It is the main staple food of the Ethiopian population particularly in the highlands where it is produced in large volume (CIMMYT, 2005). Wheat ranks second in volume of production next to maize and third in area of cultivation next to teff and maize in descending order

with the total hectareage of 1.6 million hectares and volume production of 4.5 million tons (CSA, 2017). The national average yield of wheat in Ethiopia is about 2.67t/ha (CSA, 2017). This is by far below the world’s average yield/ha which is about 3.09t/ha (FAO, 2017). This low yield is attributed to multifaceted biotic and abiotic factors such as cultivation of low yielding varieties, low and uneven distribution of rainfall, poor agronomic practices, insect pests and serious diseases like rusts (Hailu *et al.*, 1991; Solomon, 1993; Dereje and Yaynu, 2001).

Wheat stem rust caused by the fungus *Puccinia graminis f. sp. tritici* has been the most devastating of all wheat rusts worldwide (Singh *et al.*, 2008) and historically several wheat stem rust epidemics have been reported from different parts of the world (CIMMYT, 2005). However, “after Green Revolution” the disease was largely under control worldwide except in eastern Africa where the disease is still a major problem and where long-lived, more durable resistance genes, such as Sr31 have been defeated by the emergence of new stem rust race called Ug99 (Carson and Jin, 2007). Ug99 is highly damaging and is reported to cause yield losses of more than 71% in experimental fields (CIMMYT, 2005). The common and leading cultivars currently grown in Africa, Middle East, Asia as well as majority of advanced breeding germplasm of CIMMYT and ICARDA are succumbing to Ug99 (GRI, 2005).

In Ethiopia, recent studies indicated that most of Ethiopian wheat cultivars are susceptible to the previously identified races of stem rust and to the newly evolved Ug99 race and its lineages. Since evolution of ug99 race to different virulent lineages is frequent, continuous annual survey and surveillance is important to monitor its distribution and intensity as well as to evaluate reaction of the existing wheat cultivars to wheat stem rust. In general scientific information on the prevailing wheat stem rust pathogen population and reaction of wheat varieties against these pathogen populations is very important to develop scientific strategies for crop protection and breeding schemes. Thus, continuous annual survey is imperative to obtain this scientific information on the status of both the disease and the varieties employed. Therefore, the objective of this study was to assess wheat stem rust disease prevalence, incidence and severity as well as evaluation of reactions of wheat varieties grown in the surveyed area to the prevailing stem rust pathogen population in four districts of Arsi and west Arsi zones.

## 2. MATERIALS AND METHODS

### Description of the Study Area

The study was conducted in four districts of Arsi and west Arsi zones: Gedeb Asasa, Arsi Negele, Arsi Robe and Tiyo districts. The four districts of the study area were selected for their wheat stem rust hot spot areas in Arsi zones. Gedeb Asasa and Arsi Negele districts are found in West Arsi zone whereas Tiyo and Arsi Robe are found in Arsi zone.

**Table 1: Geographical location, Altitude, mean annual Rainfall and mean annual Temperature of the study area.**

Description	Study area (Districts)			
	Gedeb Asasa	Arsi Negele	Arsi Robe	Arsi Negele
Geographical location	7° 12' N, & 39° 20' E	7° 33' N, & 38° 66' E	7° 80' N, & 39° 70' E	8° N, & 39° 12' E
Altitude	2300 m.a.s.l.	1950 m.a.s.l.	2400m.a.s.l.	2200 m.a.s.l.
Mean annual Rainfall	650 mm	985mm	900mm	820mm
Mean annual Temperature				
-Min				
-Max	5.6 <sup>0</sup> C 23.6 <sup>0</sup> C	15 <sup>0</sup> C 25.4 <sup>0</sup> C	9.2 <sup>0</sup> C 22.5 <sup>0</sup> C	10.1 <sup>0</sup> C 22.7 <sup>0</sup> C

### Survey of Wheat Stem Rust Disease

The field survey was conducted in four districts of east and west Arsi Zones, namely, Gedeb Asasa, Arsi Negelie, Tiyo and Arsi Robie, districts during 2008 main cropping season. The survey was carried out to assess wheat stem rust disease prevalence, incidence and severity in the area under study. During the survey, observations were made by moving in an “X” fashion or diagonally in each filed. In each field 100 plants were observed randomly and recorded as diseased or

healthy. The number of diseased plants has been expressed as a percentage of the total number of plants giving information on disease incidence. Disease severity (percentage of stem tissue covered by the disease) was scored on 10 randomly selected plants using the modified Cobb’s scale (Peterson, *et al.*, 1948) and disease prevalence was calculated as the number of fields infected divided by the total number of fields observed.

**Data analysis**

All collected data during field survey were analyzed by using simple descriptive statistics. Mean prevalence, incidence and severity were computed and the mean differences in disease status under field conditions were compared.

**3. RESULT AND DISCUSSION**

**Survey of wheat stem rust disease**

A total of 33 wheat fields (Table 1) were surveyed in four districts of east and west Arsi zones with the aim of assessing wheat stem rust disease prevalence, incidence and severity in the areas under the study in 2008 main cropping season. Wheat variety Kubsa, Galema, Dodota, Hawi, Sofumer, Maddawalabu, Simba, Sirbo, Diglu, Meraro, Wabe, Bonde, Tuse, Paven 76 and ET-13A2 were varieties grown in the surveyed fields. Out of the total wheat varieties grown in the surveyed fields variety Kubsa covered 15.2% of the surveyed fields followed by variety Galema (12.1%). Variety Dodota, Hawi, Sofumer and Maddawalabu covered 9.1% whereas variety Simba, Sirbo and Diglu covered 6.1% and variety Meraro, Wabe, Bonde, Tuse, Paven 76 and ET-13A2 covered 3% of the total number of fields observed. Therefore, with respect to the area coverage in the surveyed fields, variety Kubsa was the most dominant, followed by variety Galama, Dodota, Hawi, Sofumer and Maddawalabu whereas variety Meraro, Wabe, Bonde, Tuse, Pavon 76 and ET-13 A2 were the least dominant preceded by variety Simba, Sirbo and Diglu(Table 1).

**Table 2: Distribution and frequency of wheat varieties in the surveyed area**

Serial No	Variety	GedebAsasa	Arsi Negelie	Tiyo	Arsi Robie	Total
1	Simba	1	1	–	–	2
2	Dodota	2	1	–	–	3
3	Hawi	2	–	–	1	3
4	Galema	2	–	1	1	4
5	Sofumer	1	–	–	1	3
6	ET-13 A2	–	1	–	–	1
7	Pavon 76	–	1	–	–	1
8	Tuse	–	–	1	–	1
9	Bonde	–	–	1	–	1
10	Wabe	–	–	1	–	1
11	Digelu	–	–	1	1	2
12	Sirbo	–	–	1	1	2
13	Maddawalabu	–	–	–	3	3
14	Kubsa	2	1	1	1	5
15	Meraro	–	–	–	1	1
	Total	10	5	8	10	33

**Wheat stem rust disease prevalence, incidence and severity**

The wheat stem rust disease survey revealed that the overall mean of disease prevalence, incidence and severity were 100%, 33.91% and 24.8%, respectively (Table 3). The analyzed data also indicated that the highest mean of disease incidence (76%) of wheat stem rust was scored in Arsi Robe district, followed by Tiyo (33.13%) and Gedeb Asasa (18.5%) districts while the lowest mean of disease incidence (8%) of wheat stem rust was recorded in Arsi Negele district. Similarly, the highest mean of disease severity (50%) of wheat stem rust was scored in Arsi Robe, followed by Tiyo (24.4%) and Gedeb Asasa (13.5%) districts whereas the lowest mean of disease severity (11.2%) of wheat stem rust was recorded in Arsi Negele district (Table 2). In general; in Arsi Robe district both the disease incidence and severity were comparatively higher than that of in other districts.

Table 3: Mean distribution of wheat stem rust in Arsi and West Arsi zones in 2008 main cropping season

Zone	District	Prevalence (%)	Incidence (%)	Severity (%)
West Arsi	Gedeb Asasa	100	18.5	13.5
	Arsi Negele	100	8	11.2
Arsi	Tiyo	100	33.13	24.4
	Arsi Robe	100	76	50
	<b>Grand mean(Overall mean)</b>	<b>100</b>	<b>33.91</b>	<b>24.8</b>

Wheat stem rust disease incidence and severity is influenced by amount of initial inoculum, climatic condition, growth stage of the host plant during infection (Roelfs *et al.*, 1992). Based on this fact, the comparative low incidence and severity of wheat stem rust disease in Arsi Negele and Gedeb Asasa districts in 2008 main cropping season, seems to fall on low amount (level) of initial inoculum during the infection time of the cropping season. The most probable reason for the low amount of initial inoculum during the main cropping season may be the absence or insufficient amount of rain fall during the off-season of 2008 in Ethiopia (FAO, 2009). FAO reported that in 2008, the *belg* (off-season) rains were universally poor. Rain was delayed by 1-2 months in the normal *belg* growing areas of Oromiya, SNNPR, and Amhara and in both Harari and Dire Dawa. Even longer delays are noted in Arsi, East Shewa and North West Shewa. This report of FAO implies that there was no timely rainfall in the off-season in Arsi zones, in which the survey was conducted. Hence, it is clear that dry condition prior to growing season can reduce the amount of initial inoculum for the next growing season, consequently resulting in reduced levels of the disease incidence and severity. Moreover, in Ethiopia, where rainfall occurs in two distinct but overlapping seasons, off-season rainfall plays a greater role in the building-up of sufficient amount of initial inoculum for the spread of pathogen population in the main cropping season. However, in 2008 off-season no rain or not timely or erratic. So, the pathogen population could not get green host crops such as volunteer plants that could serve as breeding ground for spore multiplication and this might be terminated in comparatively low levels of wheat stem rust disease incidence and severity in Arsi Negele and Gedeb Asasa districts. However, the disease incidence and severity levels of wheat stem rust in Arsi Robe district were comparatively higher. This might be attributed to the altitude (2400 masl) of the area. Due to its altitude, wheat crops are commonly planted late and they also mature late in the growing season. Therefore, the delayed off-season rainfall may contribute for a better build-up of initial inoculum level in this particular district, in comparison to the other surveyed districts.

**Reaction of wheat varieties to stem rust disease**

Simba, Kubsa, Dodota, Hawi, Galema, Sofumer, ET-13 A2, Pavon 76, Tuse, Bonde, Wabe, Digelu, Sirbo, Maddawalabu and Meraro were wheat cultivars grown in the surveyed area. Out of the total wheat varieties grown in the surveyed area; variety Kubsa was the most widely grown followed by variety Galema. Severity up to 60S/MS and 40S has been recorded on Kubsa and Galema, respectively (Table 3).

Table 4: Reaction of wheat varieties to stem rust disease

Variety	Incidence		Severity	
	Range	Mean	Range	Mean
Simba	10	10	5S-10S	7.5S/MSS
Kubsa	5-40	23	5S-60S/MS	23MS/MRMS/SS/MSS
Dodota	10-40	20	10MS/S-20S	16.7MS/SS/MSS
Hawi	10-70	33.3	20S/MS-30S	26.7S/MSMS
Galema	10-60	36.3	5S/MS-40S	22.5S/MSMSS
Sofumer	20-85	48.3	20S/MS-50S	36.7S/MSS
ET-13A2	5	5	TS	TS
Paven 76	5	5	10MS	10MS

Tuse	30	30	10MS	10MS
Bonde	30	30	5S	5S
Wabe	25	25	10S	10S
Digelu	25-80	52.5	30S-40S	35S
Sirbo	40-90	65	40S-70S	55S
Meraro	80	80	30S	30S
Maddawalabu	70-100	85	40S-80S	60S

The highest wheat stem rust disease incidence (100) and disease severity (80S) were recorded on wheat variety Maddawalabu whereas the lowest stem rust disease incidence (5) and disease severity (TS) were recorded on wheat varieties Kubsa, ET-13A2, Paven 76 and ET-13A2, respectively (Table 4). Wheat variety Simba, Bonde, Wabe, Diglu, Sirbo and Meraro showed susceptible reaction to wheat stem rust across all surveyed districts but wheat variety Kubsa, Dodota, Hawi, Galema, Sofumer, Paven 76 and Tuse showed moderately susceptible reaction in some districts and susceptible reaction in other district. For example variety Dodota, Hawi, Galema and Sofumer showed moderately susceptible reaction in fields of Gedeb Asasa district but showed susceptible reaction in Arsi Negele, Arsi robe and Tiyo districts.

#### 4. SUMMARY AND CONCLUSION

The wheat stem rust disease survey was conducted in four districts of Arsi and west Arsi zones in 2008 main cropping season. During the survey data of wheat stem rust disease prevalence, incidence, severity and reaction of wheat varieties grown in the surveyed area were recorded. The data analysis indicated that mean prevalence of wheat stem rust disease in overall districts and in each district of the surveyed area was 100% (table 3). Similarly the data analysis showed that the overall mean stem rust disease incidence and severity were 33.91% and 24.8%, respectively (Table 4) and the highest mean of wheat stem rust disease incidence was recorded in Arsi Robe followed by Tiyo and Gedeb Asasa districts whereas the lowest stem rust disease incidence was recorded in Arsi Negele district. Likewise the highest wheat stem rust disease severity was recorded in Arsi Robe district followed by Tiyo and Gedeb Asasa districts while the lowest stem rust disease severity was recorded in Arsi Negele district (Table 4).

With regard to reaction of wheat varieties grown in surveyed to stem rust disease; the survey indicated that all the wheat varieties grown in the surveyed area except variety ET-13A2 (TS) and variety Paven 76 (MS) showed susceptible reaction in one or in other location (Table 4). Thus, the survey result clearly showed the importance of replacement of the susceptible wheat varieties by resistant varieties in the surveyed area. Therefore, national and regional research institutes and centers work hard and aggressively to develop resistant wheat varieties so as to protect stem rust epidemics.

#### REFERENCES

- [1] Bekele, H.K, H.Verkiuji and W. Mwangi. 1999. Adoption of Improved Wheat Technologies in Adaba and Dodola Woredas of Bale highlands. Pp.89-95. In: Proceedings of the Tenth Regional Wheat Workshop of Eastern, Central and Southern Africa. Addis Ababa, Ethiopia.
- [2] Belay, S. and D.G.Taner.1999. Yield potential and weather risks associated with wheat production in Ethiopia. pp.316-324. In: proceedings of the Tenth Regional Wheat Workshop of Eastern, Central and Southern Africa. Addis Ababa, Ethiopia.
- [3] Carson, M. and Y. Jin. 2007. Update on Ug99 (race-TTKS) of wheat stem rust. USDA-ARS. Cereal disease laboratory. St. Paul, MN.
- [4] Carter, B. 2002. The importance of wheat quality. Agricultural horizons: Contemporary issues for agriculture. Washington State University
- [5] CIMMYT. 2005. Sounding the alarm on global stem rust: An assessment of race Ug99 in Kenya and Ethiopia and the potential for impact in neighbouring regions and beyond. Mexico City, CIMMYT.
- [6] Dereje, G. and Yaynu, H. 2001. Yields loss of crops due to diseases in Ethiopia. Pest Mgt.J.Eth.5:55-67.

**International Journal of Novel Research in Life Sciences**Vol. 6, Issue 3, pp: (18-23), Month: May - June 2019, Available at: [www.noveltyjournals.com](http://www.noveltyjournals.com)

- [7] FAO. 2009. FAO Global Information and Early Warning System on Food and Agriculture World Food Programme, Special Report FAO/WFP Crop and Food Security Assessment Mission to Ethiopia (Phase 1), 21 January 2009.
- [8] Hailu, D.G, Tanner and Mengistu H. 1991. Wheat Research in Ethiopia: a Historical Perspective. Addis Ababa. IAR/CIMMYT.
- [9] Peterson, R.F. A.B. Campbell and A.E Hannah. 1948. A Diagrammatic scale for estimating rust intensity of leaves and stem of cereals. Can. J. Res. Sect. C. 28: 496-500
- [10] Roelfs, A.P, R.P.Singh, and E.E. Saari. 1992. Rust diseases of wheat: Concepts and methods of disease Management. Mexico, D. F, CIMMYT,pp 68.
- [11] Singh R.P., Hodson D.P., Huerta-Espino Jin Y., Njau P., Wanyera R., Herrera-Foessel S.A., Ward R.W. 2008. Will stem rust destroy the world's wheat crop?, p. 271-309 Advances in Agronomy, Vol 98, Vol. 98. Elsevier Academic Press Inc, San Diego.
- [12] Solomon, A.1993. Recommended bread wheat technology in Central highlands of Ethiopia. IAR news letter, 1993.Addis Ababa, Ethiopia 8: 5-7.