

Significance of Wheat Stem Rust (*Puccinia graminis f.sp. tritici*) in Gurage Zone, Ethiopia

Arif Abraham^{1*}, Bahiru Wabela², Kifle Zerga³ and Endale Hailu⁴

^{1,2,3} College of Agriculture and Natural Resource, Wolkite University, P.O.BOX 07, Wolkite, Ethiopia

⁴EIAR, Ethiopian Institute of Agricultural Research, Ambo Plant Protection Research Center P.O.Box 37, Ambo, Ethiopia

Corresponding Author: Arif Abraham: (+251) 0923953894; e-mail: rfabraham@gmail.com

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ABSTRACT

Wheat is one of the important cereal crops of Ethiopia. It is the leading crop in land coverage and total production next to tef and maize and in productivity after maize and sorghum. Gurage highlands are also considered to be suitable areas for wheat production in the country. However, the production of wheat in this region is threatened by different wheat rusts; such as stem rust disease. So, this study was conducted with the following objectives: to determine distribution, incidence and severity of wheat stem rust in Gurage highlands. Field survey was carried out in four districts of Gurage zone. A total of 100 fields were surveyed. During survey stem rust disease was occurred in 88% of the fields surveyed in Gurage zone. The mean incidence of pathogen was 47.45%. The highest mean severity (20.68%) was recorded in Soddo followed by Cheha (12.84%). All varieties grown in the zone were attacked by the disease in one area or the other. Though, the degree of incidence and severity was varied. Varieties such as Digelu, Kenya, and Pavon76 were found to be severely affected by the pathogen. In conclusion, the survey revealed high occurrence and distribution of wheat stem rust in the study areas. Therefore, it is very important for the Ethiopian Institute for Agricultural Research, especially national wheat research program to replace these susceptible varieties with currently effective resistance genes. Additionally, it is also better to monitor pathogen distribution and populations over time to track further virulence evolution and to ensure that currently effective resistance genes are applied within a system of resistance-gene management.

Key words: Incidence, Severity, District, Gurage zone, variety, field

Abbreviations: PAs- Peasant associations, SNNPR- Southern Nations, Nationalities and Peoples Regional state, S-Susceptible, TR- Trace level

INTRODUCTION

Wheat is an important cereal crop in Ethiopia that is widely cultivated in a wide range of altitude (Hailu, 1991). According to (CSA, 2004; CIMMYT, 2005) about 36% of the Ethiopian populations are relied on wheat for their food consumption. The area under wheat production is estimated to be about 1.4 million hectares, which makes the country the largest wheat producer in Sub-Saharan Africa (Hailu, 1991; CSA, 2004). Wheat ranks third in area coverage and total production after tef and maize. The Ethiopian national average yield of wheat is about 1.4 t/ha (CSA, 2004), which is by far below the world's average yield of 2.5 t/ha (Curtis, 2002). There were different types of biotic and abiotic factors responsible for this low yield. Cultivation of unimproved low yielding varieties, in sufficient and erratic rainfall, poor agronomic practices, diseases and insect pests are among the most important constraints to wheat production in Ethiopia (Hailu, 1991; Dereje & Yaynu, 2000). Cereal rusts are the most destructive diseases of wheat worldwide (Shaw, 1963; Haldore *et al.*, 1982).

Stem rust caused by the fungus *Puccinia graminis* f. sp. *tritici* Eriks. and E. Henn, has been the most devastating of all wheat diseases under favorable conditions. This disease is also known as black rust of wheat due to the abundant production of shiny black teliospores that form at the end of the season or with unfavorable conditions (Singh *et al.*, 2002). Under favorable environmental conditions, stem rust can cause yield losses of up to 100% in susceptible wheat varieties (Roelfs, 1985b). The yield loss due to this disease is usually greatest when the disease becomes severe before the grain is completely formed, but yield losses are generally influenced by the resistance level of the cultivar grown, the weather conditions and the onset of the disease (Luig, 1985; Roelfs, 1985a). In Ethiopia, yield losses due to stem rust have been reported to be in the range of 61-100% depending on the susceptibility of the variety and environmental conditions (Eshetu, 1985; Shank, 1994).

In Ethiopia wheat is produced in many regions of the country. Oromia, Amhara, SNNP and Tigray are the major wheat producing regions in the country with area coverage of 875641.45, 529609.63, 137294.72 and 108865.39 ha respectively. In Gurage Zone 47,259 farmers were involved with an estimated area coverage

(CSA, 2015). The average productivity is lower than the average yield of other wheat producing regions in the country. The major factors for low yield are cultivation of low yielding varieties, poor agronomic practices and serious diseases like rusts (GZADD, 2009). Even though Gurage zone is one of the wheat production areas in the country; there is no enough information on the distribution, incidence and severity of stem rust of wheat. Therefore, this study was conducted with the objective of assessing distribution, incidence and severity of wheat stem rust in the study area.

MATERIALS AND METHODS

Site description

The study was conducted in major wheat producing areas of Gurage zone highlands. Geographically, Gurage Zone is located between 7.8° - 8.5° North latitude and 37.5° - 38.7° East longitude of the equator. Wolkite, the capital of the zone, is 155 km away from Addis Ababa to south west direction. Gurage zone has a total area 5932km^2 . It has 13 woradas' with a total population estimated about 1343246 (CSA, 2011). The zone comprises altitudes ranging from 1,001 to 3,500 meters above sea level (m.a.s.l). It is classified into three agro-climatic zones: Dega (high altitude) covers 28.3% of the area and ranges between 2,500-3662 m.a.s.l, Woin dega (mid-altitude) at 1,500-2,500 m.a.s.l, encompasses about 64.9% of the area, and Kolla (lowland) at 1,000-1,500 m.a.s.l covers 6.8% of the area. The mean annual temperature of the zone ranges between $13-30^{\circ}\text{c}$ and the mean annual rain fall ranges 600--1600mm. The rainfall pattern in the Gurage Zone is bimodal in which 80% of rain falls in the Krent period of June to August whereas 20% in the Belg period of February to May. According to the land utilization data of the region 298,369 ha cultivated land, 67,678ha forest, bushes and shrub covered land, 70,249.31ha grazing land, and 14,234 ha of land is covered by others (GZADD, 2009).

Survey of wheat stem rust

A survey was conducted for stem rust of wheat in Gurage zone during 2017, main cropping season. A Field survey was carried out from mid-September to mid-October during which stem rust is expected to reach its maximum severity level (Serbessa, 2003). It was carried out in four (4) districts of Gurage zone such as: Cheha,

Ezha, Soddo and Gumer that was selected based on their production status. From districts five peasant associations (PA) was selected based on their wheat production potential. From each PA five farmers field was randomly selected. A total of 100 farmers' fields were assessed during survey.

Disease assessment and sample collection

The disease measurements were made by moving diagonally in the wheat farms. In each farm 10 plants were selected randomly and recorded as diseased or healthy. The number of diseased plants were expressed as a percentage of the total number of plants giving information on disease incidence. Disease severity (percentage of plant tissue covered by the disease) was scored on 10 randomly selected plants (Peterson *et al.*, 1948). For the assessment of disease incidence, the number of diseased and disease free plants were recorded and expressed in percentage according to the following formula.

$$\text{Disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total plants inspected}} \times 100$$

Disease severity and reaction types were assessed on 10 randomly selected plants. Percent area covered was assessed on the flag, the next lower leaf and stem starting from flowering to dough growth stage (Zadoks growth scale) using the modified Cobb's scale (Roelfs *et al.*, 1992).

Data collected

The data for disease incidence and severity were collected. Additionally, different types of agronomic data such as previous crop, types of wheat varieties grown, sowing date and type of fertilizer used and general geographical information such as altitude, latitude and longitude were recorded.

Methods of data analysis

All survey data was analyzed by simple descriptive statistics. The mean difference in disease status under field conditions was compared based on their mean differences.

RESULTS AND DISCUSSIONS

Distribution of wheat stem rust in Gurage zone

During the study a total of 100 farmers' fields were surveyed in Gurage zones. The crop growth stage during field assessment varied from 7 to 9 according to Zadok's growth scale. Old varieties as well as recently released varieties were found in the zones. Relatively recently released varieties like Kenya, Enkoy, Digalu, and Pavon76, and unknown local varieties were found growing in this zone. The cultivars Digalu was the most widely cultivated in this areas. Out of 100 farmer fields surveyed, about 88 fields were infested by stem rust disease which was indicating 88% of prevalence of disease in the zone.

The survey results of earlier years of Ethiopia revealed that stem rust of wheat was commonly found in all wheat growing regions. Getaneh (1996) reported high incidence and severity of stem rust in Arsi, Bale, Shewa, Hararghe, Sidamo, Wellegga and Gojam. It has also been reported that occurrence of the disease was high except for some years where adverse climatic conditions prevail (Temam *et al.*, 1985; Mengistu *et al.*, 1991; Temesgen *et al.*, 1996; Getaneh, 1996).

Disease incidence and severity of wheat stem rust in Gurage zone

A total of 100 farms' field and 20 peasant associations (PAs) were surveyed in four districts of Gurage highlands. The incidence and severity of wheat stem rust was computed for districts and peasant associations.

Stem rust is a major disease of wheat in Ethiopia in general and Gurage zone in particular and they can cause significant yield losses and quality in years with suitable conditions. The disease intensity was different from year to year and from place to place based on type of variety grown and climatic conditions (Ayele *et al.*, 2008). The disease was more important at Soddo and Cheha than the two districts (Ezha and Gumer) (Table 1). The majority of the wheat fields assessed in Soddo and Cheha have lower elevation (<2200 masl) as compared to the elevation in the other districts. So, this elevation range has warmer climatic conditions which is suitable

for the development of stem rust. The Earlier studies conducted by Dagnatchew (1967) and Roelfs *et al.*, (1992) were also indicated that stem rust prevalence is high at lower altitudes.

The highest disease incidence mean (80%) was obtained from Soddo district with highest incidence recorded from Adazar (90%) peasant association. The lowest mean (17.6%) disease incidence recorded from Ezha district. The highest mean (20.68%) disease severity of wheat stem rust was recorded from Soddo district. The severest peasant association with disease was obtained from Adazar (34.40%) areas whereas the lowest (0.4TR) was recorded from Ezha district.

Table 1. The mean incidence and severity of wheat stem rust in surveyed region during the 2017 main cropping season.

Districts	Peasant associations	No. of fields assessed	Incidence (%)	Severity (%)
Soddo	Adazar	5	90	34.40
	Wacco	5	77	15
	Genet	5	80	18.20
	Fatto	5	70	15.40
	Tiyya	5	83	20.40
Mean		5	80	20.68
Ezha	Bozeber	5	10	0.8TR
	Ketenna	5	22	0.4TR
	Gadab	5	16	3TR
	Yewember	5	22	1.4TR
	Debenna	5	18	3.80
Mean		5	17.60	1.88
Cheha	Ferezie	5	66	16.60
	Yabagomana	5	58	13
	Jombero	5	60	22.60
	Moca	5	41	6.40
	Yewere 01	5	25	5.60
Mean		5	50	12.84
Gumer	Inzena dengazo	5	46	10.80
	Arma	5	29	2TR
	Barce	5	37	6.40
	Zizencho	5	50	7
	Burdenna denber	5	49	8.6
Mean		5	42.20	6.96

TR, means the pathogen exist as trace levels

SUMMARY AND CONCLUSION

Stem rust survey was carried out along in four Districts of Gurage zone during the 2016 main growing season. These were Soddo, Cheha, Ezha and Gumer districts. The prevalence and intensity of the disease was variable with location, crop type, variety, altitude range and the growth stage of the crop. The highest and lowest stem rust incidence and severity were observed in Soddo and Ezha Districts, respectively. The highest disease incidence was 80% from Soddo and the lowest 17.6% was from Ezha district. The highly infected field was Adazar (90%) peasant association from Soddo district. The highest mean (20.68S) disease severity of wheat stem rust was recorded from Soddo district. The severest peasant association with disease was obtained from Adazar (34.40%) areas whereas the lowest (0.4TR) was recorded from Ezha district.

In view of the high incidence and severity of stem rust on the variety Digelu that covers 95% of the area under production in the surveyed areas, it appears that there is a need for replacement of this variety by other more resistant new varieties in the production system in the zone. Since all the varieties assessed were found to be attacked by the disease, a thorough, season based regular monitoring of the pathogen is required for the areas not covered in this survey in the main wheat growing areas of Gurage zone. The commercial varieties under production indicated maximum disease incidence of 90% and minimum of 16% from Soddo and Ezha, respectively. Here in Ezha, most varieties revealed resistance type reactions and the ecology is not conducive for the disease prevailing. Therefore, this concludes that the disease occurrence in Soddo area was very high and most of the commercial varieties were susceptible to the disease. This is due to the favorable environmental conditions for wheat stem rust disease occurrence in Soddo than Ezha district.

Generally, the area under wheat production in Gurage zone has dramatically increased over the years. The majority of wheat in Gurage areas is grown by subsistence farmers, for whom the use of chemical fungicides against stem rust is uneconomical. Hence, farmers need to be continuously supplied with resistant varieties to avoid epidemics of stem rust, especially in the light of the wide distribution of new variants of Ug99 race. Therefore, it is important for the national agricultural research center to quantify and monitor pathogen

populations over time to track further virulence evolution and to ensure that currently effective resistance genes are applied within a system of resistance-gene management.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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