

Geographical Distribution, Incidence and Severity of Tef (*Eragrostis tef*) Diseases in Ethiopia

Ashenafi Gemechu Degete*

Departments of Agricultural Research, Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia

Abstract

Tef (*Eragrostis tef*) is the most important cereal in Ethiopia and is threatened by biotic and abiotic constraints. Among the biotic, tef leaf rust (*Uromyces eragrostis*), head smudge (*Helminthosporium miyakei*), smut spp and zonate eyespot (*Hemintosprium gigantum*) are among the major constraints of tef production. Information on the distribution of those diseases, occurrence and reaction of cultivars to those diseases in Ethiopia were not well known. Therefore, the aim of this survey was to observe the performance of commercial cultivars and understand the distribution of major tef diseases in the country. The survey was made in the 2020 and 2021 main cropping seasons following the main roads and accessible routes in each survey district. Five stops were made in each tef field by moving "X" fashion at each stop interval and data were collected from each. A total of 11 zones and 41 districts were covered during the survey. A total of 107 fields were surveyed and all the observed fields were infected by tef leaf rust disease and followed by head smudge. The prevalence of tef leaf rust was 100% and followed by head smudge having a mean value of 30.8% and the lowest prevalent disease was smut with a prevalence of 12.2%. The highest mean severity (38.8%) and incidence (100%) value of tef leaf rust was recorded in the East Gojam zone and followed by Silte zone with the mean value of tef leaf rust severity and incidence of 77.8 and 34.4%, respectively. The mean value of head smudge incidence and severity was 40 and 42% in the East Shoa zone followed by West Gojam with the mean incidence and severity values of 31.3 and 37.1% respectively. Of the assessed fields, the Magna variety was the most popular (35.5%) and followed by the Quncho variety which accounts for about 30.8% of area coverage. The severity of the diseases was increased because of improved agronomic practices (Row planting, informal seed system, late planting and cultivars) that are susceptible to disease become common and no chemical controls were practiced on those diseases so far. Currently, the tef leaf rust was becoming severe and using fungicide may be an option to control this disease. Evaluation of fungicides and selecting of effective ones against head smudge and smut disease will be the next work. Screening of germplasm to those diseases and selecting those tolerant lines and incorporating in the breeding program will also be another option to control those diseases in the future

Keywords: Survey; Tef leaf rust; Tef; Incidence; Severity

Introduction

Tef is endemic to Ethiopia and its major diversity is found only in that country as with several other crops, the exact date and location for the domestication of tef is unknown. However, there is no doubt that it is a very ancient crop in Ethiopia, where domestication took place before the birth of Christ. Tef is an important cereal crop in Ethiopia. The area under tef cultivation is over one million hectares of land each year. In 2016/2017, it was estimated that tef made up to 24% of all the cultivated area in Ethiopia, covering about 3.02 million hectares and grown by 6.99 million farmers (CSA, 2016/2017). Tef is grown in almost all regions of the country for home consumption since it is a preferred grain and for local market since it fetches the highest grain price compared with other cereals and is used as a cash crop by farmers. Although the crop is dominantly cultivated as sole crop, it is also grown as an intercrop or mixed crop, relay crop or in rotation with several types of crops. The crop is grown both in belg (short rainy season) and meher (long rainy season) [1]. The regions in Ethiopia identified as highly suitable for tef production include some parts of Oromia and Amhara. The central highlands of Ethiopia are suitable for tef production and are also the largest and major tef production areas in the country modern varieties are used as well as traditional landraces and local cultivars. There are different constraints of tef yield reduction. These are biotic and abiotic constraints. Biotic factors include diseases, insects and weeds and abiotic (lodging, poor soil fertility and moisture scarcity).

Tef rust (*Uromyces eragrostidis* Tracy), head smudge (*Helminthosporium miyakei* Nisikado) and smut have been reported as the most important diseases on tef. Recently other biotic factors such as loose smut and zonate eye spot diseases are observed on different tef varieties. The importance of such diseases might increase with change of agronomic practices (row planting), informal seed exchange system, lack of identified fungicides, change of climate condition and depending on a few tef varieties. To know the status of each important disease in the country doing survey is the most important. Therefore, the aims of this survey was for observing the performance of commercial cultivars and understanding the

***Corresponding author:** Ashenafi Gemechu Degete, Departments of Agricultural Research, Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia, Tel: 926897678; E-mail: gemechuashenafi@gmail.com

Received: 11-July-2022, Manuscript No. ACST-22-69075; **Editor assigned:** 13-July-2022, PreQC No. ACST-22-69075 (PQ);

Reviewed: 27-July-2022, QC No. ACST-22-69075; **Revised:** 02-January-2023, Manuscript No. ACST-22-69075 (R);

Published: 13-January-2023, DOI: 10.4172/2329-8863.1000555

Citation: Degete AG (2023) Geographical Distribution, Incidence and Severity of Tef (*Eragrostis tef*) Diseases in Ethiopia. Adv Crop Sci Tech 11:555.

Copyright: © 2023 Degete AG. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

distribution of major tef diseases in the country and prioritizing the important diseases of tef.

Materials and Methods

Survey of tef diseases

Tef diseases survey was conducted during 2020 and 2021 belg and main cropping seasons in eleven major tef producing zones of Oromia, Amhara and Southern Nation and Nationality of IIPeople (SNNP) regions were assessed. A total of 107 farmers' fields were assessed in 41 districts during the survey. During the assessment three to five stops were made along a diagonal move at each stop interval based on the availability of tef field [2].

During the survey the crop growth stage was not the same. The variation is due to planting time and tef phenology. The survey was conducted during crop growth stage of grain filling, heading and maturity based on agro ecologies of the surveyed areas. Disease prevalence, incidence and severity were recorded for tef leaf rust and head smudge disease but only incidence was calculated for the smut disease of tef. The disease prevalence was calculated using the number of fields affected divided by the total number of field assessed and expressed in percentage. Incidence was calculated by using the number of plants infected and expressed as percentage of the total number of plants assessed. Severity was scored visually using the modified Cobb's Scale where 0%=immune and 100%=completely susceptible, but there was no immune response for the reaction between tef varieties and the tef rust disease. There were no resistant and moderately resistant responses of tef varieties across the surveyed areas. For smut disease incidence was taken. Three survey routes were done based on the most tef growing regions and suitable for the occurrence of major tef diseases. Trips were arranged based on the crop growth stage and the disease occurrence. The surveys were made following the main roads and accessible routes in each survey district and stops were made at every 5 km-10 km intervals based on vehicles odometers and on the availability of tef in the farmers field [3].

The tef diseases incidence and severity of each field was computed from five stops. The results of the survey were summarized by districts and varieties. The geographic coordinates (latitude and longitude) and altitude was recorded using Geographic Positioning System (GPS) unit. The latitude and longitude coordinates were used to map the distribution of the tef leaf rust and other tef diseases in the surveyed areas using the Environmental Systems Research Institute (ESRI).

Results and Discussion

Survey of tef diseases

Tef diseases survey was covered three regions (Oromia, Amhara and Southern nation and nationality of people) which had been presented in Table 1. The prevalence of tef leaf rust and head smudge diseases were 100% in Oromia, Amhara and SNNP regions. The prevalence of smut disease was about 33.3% Oromia region. From this survey study; there was no smut disease in Amhara and Southern Nation and Nationality People (SNNP). The highest tef leaf rust incidence was found in southern nation and nationality people and followed by Amhara region with the mean values of 71% and 67.6% of the assessed areas, respectively. However, the lowest mean incidence of tef leaf rust was found in Oromia region with the mean value of 58.7%. The highest severity of tef leaf rust was found in Southern nation and nationality of people and followed by Amhara region with the mean severity value of 31.5% and 23.4%, respectively. Whereas, the lowest mean tef leaf rust severity value was recorded in Oromia with the mean severity value of 22.7%. The highest percentage of mean incidence of tef smut (5.7%) disease was found in Oromia region and followed by Southern nation and nationality of people with the mean incidence value of 2.2%. The smut disease was not found in Amhara region during the survey years. The highest mean severity value (17.8%) of head smudge was recorded in Southern nation and nationality of people in the assessed areas. However, the lowest severity of head smudge disease was recorded in Oromia region with the mean severity value of 8.6% [4].

Row labels	Mean of incid %	Mean of severity	Mean of incid HS (%)	Mean of sev HS (%)	Mean of smut incid (%)
Amhara	67.6	23.4	9	11.9	0
Oromia	58.7	22.7	7.9	8.6	5.7
SNNP	71	31.5	11.3	17.8	2.2

Incid: Incidence; SNNP: Southern Nation and Nationality of People; HS: Head Smudge

Table 1: The overall mean incidence, severity of tef leaf rust, head smudge and smut diseases across the surveyed regions.

During the survey a total of eleven zones and 41 districts were assessed (Table 2 and Table 3). The distributions and intensities of the tef leaf rust disease were observed in all surveyed zones and districts at variable levels of severity across the surveyed fields depending on the agro-ecologies, date of planting and varieties grown [5].

Tef leaf rust was the most important disease in distribution and intensity at all the surveyed regional states (Oromia, Amhara and SNNP). A total of 107 fields were observed in all assessed regions and all the observed fields were infected by tef leaf rust disease. The lowest severity of tef leaf rust was recorded in Awi zone followed by West Arsi Zones having the mean severity value of 17.1% and 20.4%, respectively. The highest mean severity (38.8%) and incidence (100%) value of tef leaf rust was recorded in East Gojam zone and followed by Silte zone with the mean value of tef leaf rust severity and incidence of

77.8% and 34.4%, respectively. The lowest tef leaf rust incidence and severity was recorded in Hawi zone with the value of 59.3% and 17.1%, respectively. Next to tef leaf rust head smudge was the most important disease of tef observed during the survey. The mean value of head smudge incidence and severity was 40% and 42% in East Shoa zone followed by West Gojam with the mean incidence and severity value of 31.3% and 37.1%, respectively. However, head smudge disease was not occurred in Alaba zone and North Shoa during the survey year. The smut disease was severe in West Arsi zone of Oromia with the incidence of 15.4%. Ashenafi Gemechu reported this disease in these areas for the first time in pocket areas but currently the disease covered two districts of West Arsi Zone and one district in Alaba zone (SNNP). However, this disease was not found in

Amhara and most zones of Oromia region and Southern nation and nationality of people.

The highest mean tef leaf rust disease severity of (40%) was recorded on mixture tef variety followed by Magna showing the mean severity value of 37%. 100% incidence was recorded on Tesfa variety during the survey years. Whereas, the lowest severity was recorded on local tef varieties Dega tef and bunign with the mean severity value of 8.3% and 12.5%, respectively (Figure 1). The highest mean severity of head smudge disease was found on Tesfa variety with the value of 43% and followed by Key Tef with the mean severity value of 21.5%. However, the lowest mean severity and incidence of tef leaf rust disease was found local variety bunign with the value of 1.9% and 2.3%, respectively[[6].

From improved variety; magna variety showed the highest severity with susceptible response with the mean severity value of 37% and

followed by Quncho variety showing the mean severity value of 33.6% with susceptible response (s). The highest incidence mean of smut disease was found on variety boset with the mean value of 5.0%. The lowest smut disease mean incidence was found on Quncho variety with mean value of 3.3%. However, the smut disease was not found on tef varieties Bunign, Dega tef, Eba, mixture tef, Magna and Tesfa.

Form the survey results; about 22.5% of the surveyed areas were covered by unimproved or local cultivars and 77.5% were covered by improved tef varieties (Figure 2). From the assessed fields Magna variety was the most popular (35.5%) and followed by Quncho variety which accounts about 30.8% area coverage (Figure 3). The Eba (0.9%) and Tesfa (0.9%) varieties percentage of area coverage were low as compared to other tef varieties [[7-10].

Zones	Mean of altitude	Mean incid of LR (%)	Mean severity of LR	Mean of incid HS	Mean of sev HS	Mean of smut incid
Alaba	1805.0	50.0	30.0	0.0	0.0	5.5
E/Gojam	2409.9	64.1	20.5	4.8	8.0	0.0
E/Shoa	1771.8	76.0	30.0	40.0	42.2	0.0
Gonder	1931.4	92.9	34.3	2.9	2.4	0.0
Gurage	1994.3	67.8	28.9	12.2	11.9	0.0
Hawi zone	2422.3	59.3	17.1	13.6	18.4	0.0
N/Shoa	2574.4	51.4	20.5	0.0	0.0	0.0
S/West Shoa	2265.0	66.0	30.0	4.0	1.0	0.0
Silte	2006.8	77.8	34.4	11.5	24.9	0.0
W/Gojam	2158.4	100.0	38.8	31.3	37.1	0.0
West Arsi	1949.0	59.2	20.4	4.2	6.6	15.4
Grand total	2223.8	65.3	24.7	9.1	11.9	1.9

Note: LR: Leaf Rust; HS: Head Smudge; Incid: Incidence

Table 2: Geographical distribution tef leaf rust, head smudge and Smut diseases incidence and severity in 2020 and 2021 main growing seasons.

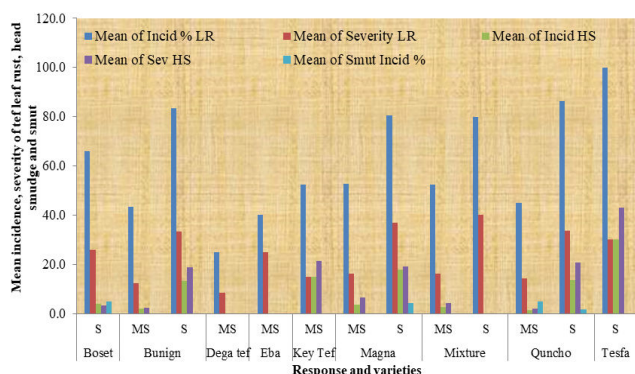


Figure1: Response of varieties for tef leaf rust, incidence and severity against each disease during the survey seasons.

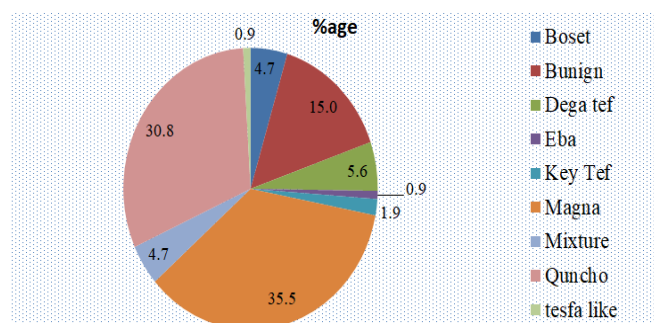


Figure 2: The percentage of area coverage of the varieties across the surveyed zones.

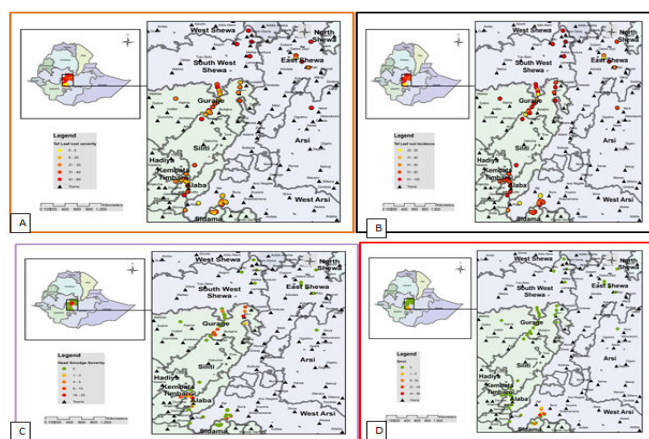


Figure 3: Distribution of tef leaf rust severity and incidence of tef leaf rust, head smudge and smut disease in the surveyed areas during the surveyed areas A) The geographical distribution of tef leaf rust severity; B) Tef leaf rust incidence; C) Head smudge severity; D) Head smudge incidence.

Woreda	Mean of incid LR	Mean of severity LR	Mean of incid HS	Mean of sev HS
Adea	60	20	50	10
Adet	100	30	0	0
Alaba	50	30	0	0
Alem Gebeya	90	40	7.5	2.5
Bichena	80	30		
Bue	90	40	15	5
Butajera	65	30	0	0
Cilili	55	15	0	0
Dangila	100	30	35	72.5
Debera Markos	50	10	0	0
Dejen	60	23.3	0	0
Dejen	50	11.25	0	0
Denbecha	100	50	75	7
Deneba	30	10	0	0
Enewary	32	14	0	0
Enjibara	60	15	0	0
Fenoteselam	100	45	20	20
Gonder	100	45	0	0
Gonder	70	20	0	0
Gonder zuria	100	30	0	0
Guatsion	75	30	0	0
Kela	65	26.25	20	7.5
Kersa Malima	90	45	10	2.5

kuyu	75	32.5	0	0
Lemen	60	25	0	0
Liben Chukala	80	32.5	37.5	8.25
Machakel	70	25	5	20
Markos	100	30	20	30
Mota	70	22.5	27.5	42.5
Negelle Arsi	48.3	16.7	5	1.7
Sankura	100	60	0	0
Selale	30	10	0	0
Shalla	20	5	0	0
Shashemene	73.3	33.3	8.3	3.3
Sheno	25	5	0	0
Silti	100	40	0	0
Sodo	40	15	0	0
Sodo Dachi	30	10	0	0
Wendogenet	80	20	0	0
Worabe	60	30	0	0
Wulbarek	64	26	20	9.4
Grand Total	65.7	24.8	13.6	9.9

Table 3: The mean value of severity and incidence of tef leaf rust, head smudge and smut diseases across the surveyed districts during 2020 and 2021 belg and main cropping seasons.

Conclusion

This study indicates the presence of multiple diseases at different growth stage of the tef, at different locations and altitude during the assessment. During the assessment, we found that different pathogens attacking tef varieties were observed across surveyed areas. Among all fungal diseases reported, tef leaf rust, head smudge and smut are diseases that were observed in surveyed areas.

Results from tef diseases survey in eleven zones reveals that tef leaf rust was prevalent and followed by tef head smudge encountered during the survey seasons with varying degree of incidence and severity. However, the occurrence of the tef leaf rust disease was 100% in all of the surveyed areas of the zones. From the assessed fields Magna variety was the most popular (35.5%) and followed by Quncho variety which accounts about 30.8% area coverage.

The highest mean severity of head smudge disease was found on Tesfa variety with the mean value of 43% and followed by key tef with the mean severity value of 21.5%. From improved variety; Magna variety showed the highest severity with susceptible response with the mean severity value of 37% and followed by Quncho variety showing the mean severity value of 33.6% with susceptible response.

Generally, from the survey results about 35.5 (Magna) and 30.8% (Quncho) of the fields were cultivated by varieties having susceptible

reaction to tef leaf rust. The incidence and severity of tef head smudge and smut diseases were increasing from year to year. Efforts should be made towards the integration of multiple disease control options. Varietal diversification is also another issue to minimize the effect of those diseases.

This study indicates that there was no the use of fungicide to control those disease. Currently, the disease was becoming severe and using fungicide (Rex Duo) may be an option to control tef leaf rust disease. For tef head smudge and smut diseases evaluation of fungicides and selecting the effective fungicide (s) are the most vital work in the future. The other issue is screening of germplasm to those diseases and selecting those tolerant line (s) and incorporating in breeding program will also another option to control those diseases in the future.

Acknowledgement

I would like to offer a great thanks to tef research team of Debre Zeit Agricultural Research Center for their valuable encouragement and technical support during the whole period of the study.

References

1. Degete AG (2021) First report of smut pathogen on Tef (*Eragrostis tef*) in Ethiopia. Plant 93: 66-69.
2. CSA (Central Statistical Agency) (2016) Agricultural Sample Survey. Report on area and production of major crops. Statistical Bulletin, Addis Ababa, Ethiopia.

3. Fufa H, Tesfaye B, Hailu T, Kebebew A, Tiruneh K (2001) Narrowing the rift: Tef research and development, proceedings of the International workshop on Tef Genetics and Improvement. Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia, 167-176.
4. Peterson RF, Campbell AB, Hannah AE (1948) A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. Can J Res 26: 496-500.
5. Berehe T (1981) Inheritance of lemma colour, seed colour and panicle form among four cultivars of *Eragrostis tef* (Zucc.) Trotter. Ph D, University of Nebraska, Lincoln, UUSA.
6. Worku WW (2004) Maize tef relay intercropping as affected by maize planting pattern and leaf removal in southern Ethiopia. Afr Crop Sci J 12: 358-367.
7. Damte T, Feleke G, Adisu S, Assefa, Tesfaye H (2019) Pests of belg and irrigated Tef (*Eragrostis tef*) in the Amhara region, Ethiopia. Ethiop Agric Sci 29: 63-71.
8. Tsegay A, Vanuytrecht E, Abrha B, Deckers, Gebrehiwot, et al. (2015) Sowing and irrigation strategies for improving rainfed tef (*Eragrostis tef* (Zucc.) Trotter) production in the water scarce Tigray region, Ethiopia. Agric Water Manag 150: 81-91.
9. Dawit, Andrew Y (2005) The study of fungicides application and sowing date, resistance and maturity of *Eragrostis tef* for the management of teff rust (*Uromyces eragrostidis*). Can J Plant Pathol 27: 521-527.
10. Assefa, Ketema S, Tefera H, Nguyen HT, Blum A, et al. (1999) Diversity among germplasm lines of the Ethiopian cereal tef (*Eragrostis tef* (Zucc.) Trotter). Euphytica 106: 87-97.