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DISTRIBUTION OF HEAD SMUDGE (HELMINTHOSPORIUMMIYAKEI) OF TEF DISEASE DURING SHORT RAINY AND MAIN CROPPING SEASONS IN SOME PARTS OF OROMIA AND SOUTHERN NATION NATIONALITY AND PEOPLE REGIONS OF ETHIOPIA

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ABSTRACT

Head smudge of tef caused by Helminthosporiummiyakei is among the most economically important disease causing significant economic losses of yield and quality.To investigate the distribution of this disease in belg (short rainy) and main (long rainy) seasons in Oromia and SNNP regions, disease assessment survey was conducted in 2019 main season and 2020 belg season from September 25 to May 22-25 G. C. Tef fields were randomly selected at 5-10 km intervals along accessible routes. The result showed head smudge prevalence and intensity varied across locations within the zone and among districts. From a total of forty-two fields surveyed during main and belg seasons (twenty three fields during the main season and ninteen fields during belg season) were assessed. Quncho was the most prevalent 34.78% and followed by Magna having the prevalence of 26.1% during the main season. Of the assessed areas, the highest incidence was observed in Sokoru districts of Jimma and Wondogenet of West Arsi Zone accounting for about 100% and with the mean severity value of 97%. The highest mean value of incidence was recorded on varieties Tesfa and Quncho with the mean value of 100 and 83.33% followed by local tef variety (80%) during the main cropping season, respectively. During Belg season survey, Boset was the most prevalent accounting for about 68.4% of the assessed areas and followed by Magna variety with the prevalence of 15.79% of the area assessed areas. Efforts should be made towards the integration of multiple disease control options. Varietal diversification is also another issue to minimize the effect of this disease. This study indicates that there was no use of fungicide to control this disease. Currently, the disease was becoming severe, and using fungicide may be an option to control this disease. The other issue is the screening of germplasm to this disease and selecting that tolerant or resistant line (s) and incorporating in the breeding program will also another option to control this disease in the future.

Keywords: Tef; Head smudge; short rainy; long rainy; severity; incidence .

1. INTRODUCTION

Tef (*Eragrostistef*(Zucc.) Trotter] is an allotetraploid (2n=4x=40) small cereal grain crop that belongs to the family Poaceae, sub-family Eragrostoideae, tribe Eragrostidae and genus Eragrostis. Tef genome has a size of 672 Mbp and it is larger than the rice genome (430 Mb)

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(Cannarozzi et al., 2014). It is a self-pollinated crop with exceptionally low level of out-crossing from 0.2% to 1.0% (Seyfu, 1997). At present, the crop is highly accepted worldwide thought for its wholesome pivotal facts since it is affluent in supplements and is gluten-free. Consumers prefer tef not only because it makes good quality “injera”, pancake-like soft bread, but also it is nutritious due to its high protein and mineral content, and the absence of gluten (Spaenij-Dekking et al., 2005) which makes it an alternative food for people suffering from celiac disease. Due to this "life-style" nature of the crop, it has been heralded as a super food or super grain (Provost and Jobson, 2014). Tef is additionally acknowledged to be lenient to outrageous environmental condition and soil conditions; consequently, it's a most valued crop in the semi-dry zones (Zerihun and Kebebew, 2012). Despite its numerous relative advantages and economic importance, the productivity of tef in Ethiopia is low amounting to 1.85 tons ha-1 (CSA, 2020). Tef is grown in almost all regions of the country for home consumption since it is a preferred grain, and for the 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 a sole crop, it is also grown as an intercrop or mixed crop, relay crop, or in rotation with several types of crops (Fufa*at el*, 2001).

In Ethiopia, about 50 improved varieties are released by national and regional agricultural research of the country mainly by DebreZeit Agricultural Research Center. Amongst these, recently released varieties namely Quncho (Kebebew et al., 2011), Kora (Kebebew et al., 2017) and Dagim (Solomon et al., 2017) showed significant yield benefits. The status/response of those released varieties against head smudge disease is not known yet during main and belg (short rainy) seasons in the country. The crop is grown both in belg (short rainy) and Meher (long rainy) seasons. The regions in Ethiopia identified as highly suitable for tef production include Gojam and Shoa, which are located in the central highlands of Ethiopia and are also the largest and major tef production areas in the country where modern varieties are used as well as traditional landraces and local cultivars during main cropping season. Currently, tef production during belg (short rainy season starting from End of February- End of May) is common in the West Arsi zone of Oromia and in some parts of southern nation nationality and people (SNNP) and becoming a common practice for the farmers.

There are different constraints of tef yield reduction. These are biotic and abiotic constraints. Biotic factors include diseases, insects and weeds and abiotic factors include lodging, poor soil fertility, and moisture scarcity. Tef rust (*Uromyceseragrustidis* Tracy) and head smudge (*HelminthosporiummiyakeiNisikado*) have been reported as the most important diseases on tef (WeleligneWorku, 2004 and Stewart *at.et*,. 1967, Ashenafi*at.et*, 2018). Previously head smudge of tef is a common disease in warm-humid areas and the incidence is high at valley bottoms near rivers and in fields bordered by shade trees but currently, the pathogen is found in most of tef cultivating areas of the country. This pathogen causes lodging as it forms mat of mycelia which ties the tef crop together and loss of grain quality and yield. Therefore, the aim of this assessment was to observe the performance of commercial cultivars and understanding the distribution of head smudge diseases during Belg (short rainy) and Meher (main cropping) seasons in the country.

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2. MATERIALS AND METHODS

Description of the study area

The survey of tef head smudge were carried out in the major tef growing regions during 2019 main and 2020 belg (short rainy) cropping seasons. The surveys were carried out in Oromia and Southern Nations, Nationalities People (SNNP) of Ethiopia. During both seasons survey, five zones (two Oromia and three SNNP) and ten districts during 2019 main cropping season and three districts during 2020 belg (short rainy) season were assessed. Survey stops were made at every 5-10 km intervals based on vehicle odometers following main and feeder roads in areas where tef is important during belg (short rainy) and main growing seasons and head smudge disease is known to be present.

Assessments of Head Smudge Disease of Tef

The assessment was conducted during both years at the maturity growth stage of the crop for each field.Disease assessments were made at five points along the two diagonals (in an ''X'' pattern) of the field using a quadrant (0.5m x 0.5m=0.25m^2) and used to calculate average values.

The incidence was calculated by using the number of infected panicles and expressed as a percentage of the total number of panicle assessed based on the International Rice Research Institute (IRRI, 2013) and the scoring of the disease is based on1-9 scale adopted from fusarium head blight of wheat disease. Where 1 < 5%, 2 = 5–17%, 3 = 18–30%, 4 = 31–43%, 5 = 44–56%, 6 = 57–69%, 7 = 70–82%, 8 = 83–95% and 9 > 95% of the spikelet's with FHB symptoms.

$$\text{Disease incidence: DI (\%)} = \frac{\text{Number of diseased panicle in quadrant}}{\text{Total number of panicle observed in a quadrant}} X\ 100$$

The prevalence of disease was measured by using the number of fields surveyed divided by the total number of fields infected by the pathogen and expressed in percentage.

Besides, data on geographical information (latitude, longitude, and elevation) of each field were recorded using Geographical Positioning System (GPS).

Data analysis

The data were analyzed by using descriptive statistics (Gomez and Gomez 1984). The SPSS software programs were used to compute the mean incidence and severity of the pathogen of the surveyed areas

3. RESULTS AND DISCUSSIONS

Distribution of tef head disease

During the 2019 and 2020 main and belg (short rainy) cropping seasons a total of ten districts and three were assessed, respectively. A total of forty-two fields were assessed during both seasons.

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Head smudge was observed in all surveyed zones of the two regions at variable incidence and severity levels. The results of the assessments showed that the intensity of tef head smudge disease varied from small to complete infection in tef fields based on the tef variety grown and agro-ecological divergence. During the assessment, the disease was observed on all the surveyed fields of surveyed areas. It was prevalent in all assessed districts of the zones in the regions. Head smudge disease was prevalent in all assessed districts of the zones and its intensity among the districts. The highest incidence (100%) and severity (97%) was observed at Wondogenet having the minimum and maximum altitude of 1865-1981m.a.s.l. The disease was more prevalent at Wondogenet and Shashemene districts during short rainy season with the incidence and severity of 100, 97 and 82%, 89.1, respectively (Table 1). Moreover the locational variations in disease distribution, the field assessment results showed that there was a wide distribution of head smudge across the districts of the zones in the seasons.

Table 1. Distributions of tef head smudge disease across zones, Districts and at different altitude during both surveying seasons

			During the 2019					**During the 2020**		
Zones	Districts	Altitude m.a.s.l	inspected fields	Incidence mean	Severity mean	Districts	Altitude m.a.s.l	inspected fields	Incidence mean	Severity mean
West Arsi Zone	Aje	1691	1	50	76	NegelleArsi	1912-2168	5	68	78.6
	Shalla	1694-1698	2	35	77.6	Shashemene	1858-1981	10	82	89.1
	Shashemene	1824-1858	8	63	76.6	Wondogenet	1865-1980	4	100	97
	Wondogenet	1923	1	100	97	Total Fields		19		
Kembata	Damira	2257	1	40	50					
	Doya	2176	1	50	89					
Hadiya	Hadiya	2127-2198	2	45	76					
Gurage	Wolkite	1840-1920	2	65	89					
	Endibir	1947-1981	2	65	76					

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Jima Zone	Sokoru	1857-1869	3	100	97

Of the assessed areas, the highest incidence was observed in Sokoru district of Jimma and Wondogenet of West Arsi Zone accounting for about 100% during the main cropping season. The highest severity of head smudge disease was observed also at Sokoru (Jimma zone) and Wondogenet (West Arsi Zone) having a value of 97% severity during the main cropping season. During belg (short rainy) season the highest incidence (100%) and severity (97%) was recorded at Wondogenet district of the West Arsi zone (Table 2).

Table 2. Mean of incidence and severity of head smudge during 2019 main and 2020 belg seasons across each district

	During the 2019 Main season				**During the 2020 Belg season**		
Districts	inspected fields	Incidence mean	Severity mean	Districts	inspected fields	Incidence mean	Severity mean
Aje	1	50	76	NegelleArsi	5	68	78.6
Damira	1	40	50	Shashemene	10	82	89.1
Doya	1	50	89	Wondogenet	4	100	97
Endibir	2	65	76	Total Fields	19		
Hadiya	2	45	76				
Shalla	2	35	77.6				
Shashemene	8	63	76.6				
Sokoru	3	100	97				
Wolkite	2	65	89				
Wondogenet	1	100	97				
Total Fields	23						

During the survey of two seasons, different varieties were observed across Zones and districts.

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During the main season survey; the Quncho variety was prevalent (34.78%) in area coverage and followed by Manga and Boset which accounts for about 26.1 and 21.74% of assessed areas, respectively.

During Belg season the highest incidence was recorded on variety Tesfa with the value of 100%. The nature of this variety is different from others having the compacted head or panicles.

This compactness is conducive for the pathogen to produce mycelia and this mycelia forms mat which tie one lines with the others (Figure 1).

Figure 1. Head smudge disease observed on Tesfa variety

The highest mean of severity during the main season was recorded on varieties Quncho (88.67%) Tesfa (97%) and Local (97%) with the mean incidence value of 83.33, 100, and 80% responses, respectively (Table 3). The lowest incidence and severity was 42 and 73.4% on variety Boset was recorded during the main season, respectively. While during belg (short rainy) season the highest severity (97%) and incidence (100%) was recorded on Tesfa variety followed by Quncho and Boset having the mean value of severity 89 and 86.1%, respectively. During belg (short

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rainy) season the lowest incidence (53.33%) and severity (71.67%) was recorded on variety Magna during the short rainy season (Table 3).

During Belg (short rainy) season survey, Boset was the most prevalent accounting for about 68.4% of the assessed areas and followed by Magna variety which accounts for about 15.79% with the prevalence of the area assessed areas. Boset (DZ-Cr-409) is recommended for terminal drought-prone areas protracted rainy season and altitudes of 1200-1800 meter mean above sea level. The remaining varieties were classified under high potential areas with sufficient rainfall.

Table 3.Tef varieties distribution, mean incidence, prevalence and severity of tef head smudge during 2019-2020 main and belg (short rainy) seasons in the surveyed areas

	During 2019 Main season				**During 2020 Belg season**				
Varieties	inspected fields	prevalence	Incidence mean	Severity mean	Varieties	inspected fields	prevalence	Incidence mean	Severity mean
Boset	5	21.74	42	73.4	Boset	13	68.4	80.77	86.1
Magna	6	26.1	52	73.4	Magna	3	15.79	53.33	71.67
Mixture	2	8.7	65	82.5	Mixture	1	5.26	60	89
Quncho	8	34.78	83.33	88.67	Quncho	1	5.26	80	89
Tesfa	1	4.35	100	97	Tesfa	1	5.26	100	97
local	1	4.35	80	89	Total fields	19			
Total fields	23								

4. CONCLUSION AND RECOMMENDATIONS

Even though the yield loss caused by this pathogen is not studied and quantified in the study areas and crop, this study indicates the distribution of head smudge is becoming prominent in the surveyed areas. In this study, the disease was observed across the surveyed areas. Results from tef head smudge survey in a total of forty-two surveyed fields reveal that head smudge was prevalent in the surveyed areas wheretef variety is grown during the belg(short rainy) and main cropping seasons with varying degrees of incidence and severity. The disease was severe in Wondogenet (97%), Sokoru (97%) during the main cropping season. During the main season, Quncho variety was the most prevalent (34.78%) and followed by variety Magna which accounts

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for about 26.1% in area coverage. Of the two dominant varieties (Quncho and Magna) the highest severity was recorded on Quncho (88.67%) and followed by Magna (73.4%).The disease was more prevalent at Wondogenet and Shashemene districts during short rainy season with the incidence and severity of 100, 97 and 82%, 89.1, respectively. Moreover the locational variations in disease distribution, the field assessment results showed that there was a wide distribution of head smudge across the districts of the zones in the seasons.

During belg (short rainy) season survey; the highest head smudge disease severity was recorded at Wondogenet (97%) district and followed by Shashemene having the mean severity value of 89.1%. During belg season survey Boset variety was the most prevalent and covered 68.4% of the assessed areas. 15.79% of the assessed areas were covered by Magna variety. The severity of the disease was increased because of the coinciding of heading time with rainfall in the season and this favors the pathogen to grow easily.

Generally, forty-two districts were surveyed. Of the surveyed areas 34.76, 4.35, 4.35, and 8.7% of the fields were planted by susceptible varieties of Quncho (88.67%), Tesfa(97%), Local (97%), and Mixture (82.5%) during the main cropping season, respectively. Since the pathogen is debris and seed born; minimizing the use of those susceptible varieties is very crucial in the reduction of the inoculum and spread of the pathogens as well. Efforts should be made towards the integration of multiple disease control options against this disease. Varietal diversification is also another issue to minimize the effect of this disease. Currently, the disease was becoming severe and evaluation of registered fungicides for the control of this disease may be an option to control this disease. The other issue is the screening of germplasm to this disease and selecting a tolerant or resistant line(s) and incorporating in the breeding program will also another option to control head smudge disease in the future.

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