International Journal of Sustainability Management and Information Technologies
2025, Vol. 11, No. 1, pp. 21-34
https://doi.org/10.11648/j.ijsmit.20251101.12

Research Article

Assessment of Diseases for Major Cereal Crops in Buno Bedele, Ilu Aba Bor and Jimma zones of Southwestern Oromia, Ethiopia

Takele Kusa*, Latera Dore, Jara Regassa

Oromia Agricultural Research Institute, Bedele Agricultural Research Center, Bedele, Ethiopia

Abstract

A field survey was conducted to assess diseases of three important cereal crops i.e Maize, sorghum and Tef in parts of Southwestern Oromia: Buno Bedele, Ilu Aba Bora and Jima Zones during 2020 to 2022 main cropping season, covering 143 farms altogether. Prevalence, incidence and severity of each disease were scored. A total of 13 major diseases were recorded across six districts on three major cereal crops. This study indicates the presence of multiple diseases at different growth stage of the Maize, Sorghum and Tef cereal crops, at different locations and altitude during the assessment. During the assessment different pathogens attacking those cereal crops varieties were observed across surveyed areas. Diseases recorded on maize include Turcicum Leaf Blight (Exserohilum turcicum), Gray Leaf Spot (Cercospora zeae-maydis), Culvularia Leaf Spot, Maize Lethal Necrosis Disease, Aspergillus ear rot, Maize Streak Virus and Corn Smut (Ustilago maydis). Major diseases recorded on sorghum include Anthracnose (Colletotrichum sublineolum), Leaf Blight (Helminthosporium turcicum Pass), Downy Mildew (Peronosclerospora sorghi), Covered kernel Smut (Sphacelotheca sorghi) and Loose Smut (Sporisorium sorghi. Three diseases i.e head smudge, leaf rust and zonate eye spot were recorded on tef crop. Hence, the information obtained from this survey result gives some evidence on the importance research intervention in the area particularly by developing or adopting integrated disease management options for those recorded major diseases of the cereal crops in the surveyed areas for sustainable cereal crops production. Farmers are responsible for growing and harvesting cereal crops, as well as managing their farms and resources, use resistant variety. They also need to adopt and implement sustainable farming practices that can prevent and control cereal crop diseases, such as crop rotation and intercropping with non-cereal crops, such as legumes and oilseeds, pest management, and soil conservation.

Keywords

Distribution, Status, Major Cereal Disease, Prevalence, Severity

1. Introduction

Agriculture is the fundamental driver for Ethiopia's economy and long-term food security as it offers about 80-85% of employment, more than 61% of the total export and 38.5% of gross domestic product of the country [19]. Cereal crops are plants belonging to the grass family Poaceae that are grown and harvested primarily for their edible

*Corresponding author: takelekusa01@gmail.com (Takele Kusa)

Received: 26 December 2024; **Accepted:** 17 January 2025; **Published:** 11 February 2025

grain [42]. The economic and social importance of cereal crops cannot be understated, as they provide fundamental nutrition for the vast majority of the world's population. Most cereal crops are grown primarily for their grain, which contains a nutritional starchy endosperm, and forms a staple part of the human diet. The productivity of major crops in Ethiopia has been consistently below the global average. In Ethiopia, the national productivity of major crops for 2018 is 2.257 t/ha. Southern Ethiopia has a 1.882 t/ha productivity growth record for the same year, which is by far below the national average [15, 46]. Moreover, the average national productivity of cereals such as maize, wheat, tef, barley, and sorghum in 2018 were 2.11, 1.66, 5.8, 2.3, and 1.85 t/ha, respectively. Pests (weeds, diseases, and insect and other pests) are major constraints that play great role in reducing cereal production and productivity in different parts of Ethiopia. The impact of these biotic factors on the general crop performance, yield and grain quality varies depending upon the genetic, environmental, management conditions and the interactions of these factors. Many different types of organisms can infect cereal crops, including a range of bacteria, oomycetes, fungi, viruses and nematodes [18]. Fungal diseases are considered to be one of the most dominant groups of cereal crop pathogens, with agents causing disease at every level of plant physiology [18, 22]. Different fungal infections can thus cause a wide range of symptoms that can all contribute to yield losses. Thus it is very crucial to assess and record major diseases of cereal crops. The identification of major crop diseases in a given area is fundamentally important for developing management options. More over as there is often dynamism in pests- where climate change, farm activities and other human interventions tend to alter statuses of crop pests, it is quite necessary to periodically record their status and distribution. In line with this, the study was initiated to assess and identify diseases of major crops in Buno Bedele, Ilu Aba Bora and Jima zones and to assess prevalence, incidence and severity of major cereal crops.

2. Materials and Methods

2.1. Description of the Study Area

The field survey was conducted in Buno Bedele (Bedele, Gachi and Chora Districts), Ilu Aba Bora (Matu, Bure and Halu Districts) and Jima (Seka Chokorsa, Karsa and Shebe Sombo) Zones during 2020-2022 main cropping seasons (Table 1). The diseases survey was conducted to assess the prevalence, incidence and severity of major cereal crops: Maize, Tef and Sorghum. In most of the areas, the survey was conducted during dough crop growth stage. Geographically the surveyed area falls under an elevation of 1749m.a.s.l to 2244m.a.s.l for Buno Bedele, 1499m.a.s.l to 1775m.a.s.l for Ilu Aba Bora and 1337m.a.s.l to 2055m.a.s.l for Jima Zone.

2.2. Field Survey

The survey was conducted in 18 Kebeles and 143 mean fields in the nine districts of the three zones. Purposive sampling technique was applied in the survey areas. Kebeles were randomly selected from each district and based on their representativeness of cereal production of the area. The number of fields assessed from each crops were: Maize 56 samples, Sorghum 46 samples and Tef 41 samples (Table 1). The locations between successive samples of same crop (between maize and maize, Sorghum and Sorghum and Tef and Tef) were at least 3-5 km apart depending on the topography and the relative importance of the crop within each location. Random sampling techniques were used to evaluate the samples. Five samples from two diagonal selected sides were taken and from each (2m ×5m) i.e. 10 m^2 area ten plants were evaluated for their diseases reaction. Questioner was prepared to interview farmers on issues like variety grown, proceeding crop, planting date, seed rate, weed management practices, fertilizers used and rate, diseases observed, fungicides used and others. In each field, plants within the quadrates were counted and categorized into healthy and diseased ones.

2.3. Disease Scoring

Visual identification of the disease was used on all visited fields. The assessment was done for disease prevalence, incidence and severity for each crop in the reported locations.

2.4. Disease Prevalence

Disease prevalence was calculated using the formula:

$$\text{Disease prevalence (\%)} = \frac{\text{Number of locations showing plant disease}}{\text{Total number of location or fields}} \times 100$$

2.5. Disease Incidence

Disease incidence was determined in each field on the basis of visual symptoms and by counting the number of symptomatic or infected plants in a sample of total plants in randomly selected samples. In each field of 10 plants in the middle of each 1m^2 areas were randomly selected and the number of plants having foliar disease symptoms on a whole plant basis counted and expressed as a percentage of the plant population. Any unknown disease samples were collected and put in paper bags for further inspection in the laboratory. To determine the incidence of cereal crops disease at different farm fields used the following formula [6]. The formula for determination of incidence is:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of Diseased plants observed}}{\text{Total number of plants examined}} \times 100$$

2.6. Disease Severity

The level of disease severity for each field was determined by using visual disease rating scale as given below:

$$\text{Disease Severity (\%)} = \frac{\text{Area of plants tissue affected}}{\text{Total number of plants affected}} \times 100$$

2.7. Data Analysis

Data was analyzed using SPSS software. Analysis was conducted by disaggregating important relevant information by district and region so that comparison could be made.

3. Result and Discussion

3.1. Status and Distribution of Cereal Crops and Diseases

Many of the surveyed areas have been conducting for three years were very good in terms of Maize, Sorghum and Tef production. Among the three Zones were conducted surveying for three years, 40.3% in Buno Bedele, 22.1% in Ilu Aba Bora and 11.9% in Jima Zones were covered by Maize production. In terms of Maize varieties produced in Buno Bedele Zone, 27.1% was BH-661, 4.6% was same Limu and Shone, 3.3% was Local and 0.7% was BH-547 was covered by Maize production. In Ilu Aba Bora Zone 13.5% was BH-661, 6.75% was Local and 1.8% was Limu Varieties and Similarly, 8.32% was BH-661, 2.6% was Local and 1% was Limu varieties covered by Maize production in Jima Zone of surveyed areas. The sources of these maize varieties were from local, union and the seeds were improved varieties. The same to other sources of maize seed varieties, improved seed varieties were the most affected by diseases in all three zones.

According to the cereal crop survey conducted in Southwestern Oromia, the main concern was the lack of improved sorghum seeds that mature in a short period of a few months. According to the results of the survey, 100% of the farmers in all three zones were using long-standing local seeds.

Although not as much as Maize was produced as in Buno Bedele zone, Tef was produced in large quantities. However but 66.5% produced local seed ("Tsedey" and "Gerawo") from farmers and markets and 33.5% produced improved seed variety (Kuncho, Dursi and Korra) from FTC, and more recently from BeARC. According to surveys conducted in Ilu Aba Bor and Jima zones, farmers were prefer to sow in off season ("Bonee") rather than tef sowing during main season due to the worsening of Tef head smudge in main season. Of the surveyed farmers who produced in main season, 41% sow local seed and 26% improved variety in Jima and 44% local seed in Ilu Aba Bor zones due to fear of this disease. The remaining farmers were sown during the off-season in both zones. Results of the survey indicated that out of 143 totals farmers' field were sampled; maize fields (39%) was the highest samples taken in the three surveyed zones followed by sorghum and tef fields with 32% and 29% respectively.

Prevalence of most foliar diseases varied from field to field depending on environmental conditions, tillage practices, cropping sequence, and cultivar susceptibility. Moderate temperatures and moisture in the form of rain and heavy dew usually favor development of foliar diseases and more than one type can be present on individual plants.

3.2. Maize Diseases

Prevalence, Incidence and Severity of Maize Diseases

Results of the survey indicated that the major maize diseases that prevailed in the study area include Turcicum Leaf Blight (*Exserohilum turcicum*), Gray Leaf Spot (*Cercospora zeae-maydis*), Culvularia Leaf Spot, Maize Lethal Necrosis Disease, Aspergillus ear rot, Maize Streak Virus and Corn Smut (*Ustilago maydis*). These diseases were highly prevalent with high level of incidence and severity particularly in the nine districts of the three zones (Table 1). Diseases of economic significance in maize production systems of Ethiopia are TLB (caused by *Exserohilum turcicum*), GLS (caused by *Cercospora zeae-maydis*), streak disease of maize (maize streak virus), CLR (caused by *Puccinia sorghi*) [59-60] and the recently emerged viral disease, MLN caused by the combination of maize chlorotic mottle virus (MCMV) and sugar cane mosaic virus (SCMV) [41].

According to the results of the survey, the highest prevalence of maize Turcicum Leaf Blight was recorded in Bedele (92.2%), Gachi (96.7%), Chora (95%), Bure (93.8%) and Shebe Sombo (92.6%) districts. In Africa, where maize and sorghum are the staple foods, TLB is reported to be widespread in the warm and humid growing regions of Ethiopia, Tanzania and Uganda [1, 57].

Maize grey leaf spot was prevalent in all maize producing zones of in the surveyed areas. It was first reported in Ethiopia in 1997 in the border of west Wellega and Ilubabor zones, of western Ethiopia [16, 8]. According to the survey results, Gray Leaf spot was high (100%) prevalent in Bedele (93.7%), Gachi (93%), Matu (93.3%) and Seka Chokorsa (93.8%) districts. The most possible reason could be due to the irregularity in environmental condition, production systems and practices and the variety grown. The previous study of [16] reported that increased prevalence of gray leaf spot in the major maize producing regions of Western, Southern and Northwestern parts of Ethiopia. Cropping methods such as mono or inter-cropping and use of cultivar mixture are also recognized to supply to disease pressure in positive or negative ways [3]. Maize Curvularia leaf spot (CLS) is one of the common foliar fungal diseases of maize that is widely distributed worldwide [40]. According to the survey results, the

highest prevalence (71.7%) was recorded in Gachi district of Buno Bedele Zone.

Maize Aspergillus ear rot is a serious disease that affects maize yield and grain quality worldwide [23]. Among the many varieties of maize produced in the surveyed areas BH-661 and Local were susceptible to ear rot disease. According to evaluation maize variety for ear rot [45] of all released hybrid maize, the most tolerant varieties to ear rot were BH540 and BH660, with scores of 14.67% and 19.00% respectively and the variety Melkassa 7, Local, BH661, BH543, Gibe1, BHQP542, BHQPY545 and Melkassa6 were most susceptible with the score of 50.15%, 80.00%, and 64.33%, 64.00%, 50.00%, 46.62%, 49.66% and 44.33% respectively. As the surveyed results showed, the highest prevalence (42.1%) maize ear rot disease was recorded in Gachi district of Buno Bedele Zone. Maize streak virus (MSV) distribution was also observed in some surveyed districts, however the disease rest prevalent than the other of recorded foliar disease. In three years field survey mean data indicated that the highest MSV prevalence was recorded on lowlands of Matu (37%) followed by Shebe Sombo (33.3%) district. But the lowest MSV prevalence was occurred at lowland area of Halu district (11.1%). Earlier, similar findings in Ethiopia reported the distribution and importance of maize streak disease in some parts of the country [28, 5].

According to the results of the survey, the highest prevalence (55.6%) of Corn smut was recorded in Gachi of Buno Bedele zone. Accordingly, the highest prevalence (33.3%) of Maize Lethal Necrosis disease was recorded in Chora district of Buno Bedele zone. Earlier, similar findings in Ethiopia reported the distribution and importance of MSD in other parts of the country [29, 5].

Recent report showed that MSD incidence of up to 58% was also found in Ethiopian maize germplasm [29]. According to the results of study showed that maximum Incidence of Maize diseases were recorded by Maize Lethal Necrosis Diseases and followed by Gray Leaf Spot and Turcicum Leaf Blight where the disease prevailed 92%, 82.2% and 81.4%, respectively (Table 1). According to the results of study showed that all commercial and local maize varieties were more or less affected by MLN disease and no resistant variety were observed in all the assessed regions except slight tolerance of BH-661 at few areas and farmers do not practiced crop rotation. Lack of crop rotation and field sanitation were increase of insect populations responsible for virus transmission could be the reason behind this outbreak [11, 62]. In highly susceptible and late sown genotypes, MSD can cause up to 100% yield losses in infected crops [4, 38, 39].

The maximum Gray Leaf Spot incidence was recorded in Seka Chokorsa and Gachi districts followed by Bedele district. Planting susceptible maize varieties under high relative humidity was common in districts with a high disease incidence and severity index. According to [8] the development of GLS disease is fostered by humid and warm conditions. According to the survey results showed, the farmers' fields were produced by the same family crops such as sorghum, tef and hot pepper year after year without using crop rotation. Rotation of maize with a non-host crop because maize is the only known host crop for GLS, soybean and potato can successfully reduce disease inoculums [61, 21].

Similarly, the maximum Turcicum Leaf Blight incidence was recorded in Chora and Bedele districts followed by Gachi district. Plant population and fertilize application rate influence the incidence and severity of Turcicum leaf blight of maize. The use of fertilizer at the right rate is very good for the health and productivity of maize crop. Fertilized and non-fertilized maize fields were assessed during the survey varied in the level of TLB incidence and PSI when calculated per hectare. According to the results of the survey conducted of 56 maize farmers' fields were assessed 14% use fertilizer above rate, 20% use fertilizer below rate and 66% use fertilizer as determined by the rate. TLB of maize percent disease index was significantly reduced in treatments that received optimum fertilizer dosage compared to others [36]. It is known that plants suffering from nutrient deficiencies are weaker, slow in growing, and faster in aging. Such plants are susceptible to pathogens [3]. Proper of sowing time of maize is also very important to minimize the incidence of TLB disease. However, in cases of high disease incidence, both early- and late planted maize may be severely damaged by TLB [34].

The highest Maize streak virus incidence was recorded in Matu district with incidence of 23.3% and followed by Bedele (20%) district (Table 1). Recent report showed that MS incidence of up to 58% was also found in Ethiopian maize germplasm [28]. Maize Culvularia Leaf Spot was ranked fourth out of all our survey zones and the highest incidence of Maize Culvularia Leaf Spot was recorded in Gachi (41.1%) district. The level of disease incidence depends first on the maize cultivar's resistance. Similarly, the highest incidence of corn smut and Aspergillus ear rot was recorded same in Gechi district with incidence of 26.3% and 23% respectively. The maize corn smut disease has a major impact on corn production globally [25] and can infect corn at all phonological phases.

The survey result revealed that severity of Turcicum Leaf Blight was ranged from 17.9% -36.6% in Buno Bedele Zone, 20.4%-24.4% in Ilu Aba Bor zone and 17.9%-18.7% in Jima Zone. The study revealed that Turcicum Leaf Blight was more common and severe on varieties such as Local and in some BH-661. In contrast, varieties such as BH-547, Limu and Shone performed relatively better than others with respect to the Turcicum Leaf Blight reaction in the surveyed areas. Earlier survey reports [30, 49] indicated that cultivar susceptibility and weather parameters play an important role in influencing TLB severity. Turcicum leaf blight is reported to cause devastating damage on most commercial varieties of maize released in Ethiopia [56]. The survey result revealed that Maize Lethal Necrosis Disease was prevalent in major maize growing districts with the severity level ranging from 0.0% to

85.6% (Table 1). The most affected fields were found in Bedele district with 85.6% disease severity, followed by Matu and Bure districts with 84.5% and 84.3% severity levels, respectively. The survey result showed that high Gray Leaf Spot severity of 50.8% was observed in Chora district followed by 32% in Karsa, 31.3% in Matu and 30.2% in Halu districts. This proposes that variation in existing weather condition, cultural practices, lack of crop rotation and difference in genetic background of maize genotype planted by farmers in the zone encourage the development of the fungus. Curvularia leaf spot disease of maize has been described as one of the major diseases affecting maize plants in the humid tropics [33]. The survey result showed that Culvaria Leaf Spot of maize was prevalent in all the surveyed zones except some districts with severity level ranging from 6.1% in Karsa to 28.9% in Chora districts. The survey result showed that the maximum disease severity was observed at grain growth stage and filling stage.

The severity of Maize streak virus ranged from 5.1% in Halu to 12.6% in Matu district of Ilu Aba Bor zone and 3.3% in Karsa to 7.9% in Shebe Sombo districts of Jima zone. According to the results of the survey showed, many maize fields were severely affected by FAW and have a large number of various insects were susceptible to maize streak virus infection. The severity of maize ear rot ranged from 3.6% in Gachi to 5% in Bedele and Chora districts of Buno Bedele Zone, 2.5% in Halu to 5% in Matu districts of Ilu Aba Bor zone and 3.8% in Karsa to 5% in Seka Chokorsa districts of Jima zone. The survey result showed that the severity of maize ear rot was much worse on late planting due to lack of rainfall and fertilizer. Maize common smut Severity was observed in all maize field districts and planting varieties were severely by common smut except in Seka Chokorsa district of maize fields. The severity of maize common smut ranged from 6.7% in Gachi and Chora to 7.9% in Bedele districts, 2.5% in Matu to 5% in Halu districts and 3.3% in Karsa to 7.1% in Shebe Sombo districts. Agrios stated that any maize cultivar, resistant to corn smut disease, had been unknown but some maize cultivars could be tolerant to U. maydis [2].

Table 1. *Percentage of Prevalence, Incidence and Severity Index of Maize crop diseases surveyed fields.*

Zone	Districts	Elevations (m.a.s.l)	Number of field assessed	Diseases of Major Crops	Disease measurement		
					P%	I%	S%
Buno Bedele	Bedele	1857-1969	9	Turcicum Leaf Blight	92.2	75.6	17.9
				Corn smut	40	14.3	7.9
				Aspergillus ear rot	17	20	5
				Gray Leaf Spot	93.7	75.6	27.9
				Culvularia Leaf Spot	51.3	37.5	18.5
				MLN Disease	31.3	92	85.6
				Maize Streak virus	23.3	20	1.7
	Gechi	2075-2234	9	Turcicum Leaf Blight	96.7	68.9	32.6
				Corn smut	55.6	26.3	6.7
				Aspergillus ear rot	42.1	23	3.6
				Gray Leaf Spot	93	82	26.8
				Culvularia Leaf Spot	71.7	41.1	18.2
				MLN Disease	10	30	73.2
	Chora	1749-1970	7	Turcicum Leaf Blight	95	81.4	36.6
				Corn smut	22.2	16.7	6.7
				Aspergillus ear rot	37.8	20	5
				Gray Leaf Spot	72.2	48.6	50.8
				Culvularia Leaf Spot	64.3	37	28.9
				MLN Disease	33.3	90	81.2
Ilu Aba Bora	Matu	1680-1754	6	Turcicum Leaf Blight	85.2	48.3	20.4

Zone	Districts	Elevations (m.a.s.l)	Number of field assessed	Diseases of Major Crops	Disease measurement		
					P%	I%	S%
Jima	Bure	1499-1775	9	Corn smut	22	5	2.5
				Aspergillus ear rot	27.8	5	5
				Gray Leaf Spot	93.3	66	31.3
				Culvularia Leaf Spot	66.7	26.7	15.9
				MLN Disease	11	56.7	84.5
				Maize Streak virus	37	23.3	12.6
				Turcicum Leaf Blight	93.8	35.6	24.4
	Halu	1604-1703	8	Corn smut	15.6	6	3
				Aspergillus ear rot	9.3	6.7	3
				Gray Leaf Spot	81.5	33.3	29.4
				MLN Disease	8.9	36	84.3
				Maize Streak virus	24.1	15	10
				Turcicum Leaf Blight	84.1	61.4	23.7
	Seka Chokorsa	1798-2003	4	Corn smut	22.2	8	5
				Aspergillus ear rot	16.7	7.5	2.5
				Gray Leaf Spot	61.9	37.1	30.2
				Culvularia Leaf Spot	41.7	26.3	18.5
				MLN Disease	11	45	76.4
				Maize Streak virus	11.1	10	5.1
				Turcicum Leaf Blight	83.3	51.7	18.7
	Karsa	1709-1794	8	Gray Leaf Spot	93.8	82.2	28.9
				Aspergillus ear rot	20.4	11.7	5
				Maize Streak virus	22.2	10	5.8
				Turcicum Leaf Blight	83.3	48.8	18.7
	Shebe Sombo	1337-1667	4	Corn smut	29.6	8.3	3.3
				Aspergillus ear rot	36.1	20	3.8
				Gray Leaf Spot	72.2	51.7	32
				Culvularia Leaf Spot	35.2	8	6.1
				MLN Disease	13.3	34	70.3
				Maize Streak virus	22.2	6.7	3.3
				Turcicum Leaf Blight	92.6	55.6	17.9
				Gray Leaf Spot	74.1	38.9	15.4
				Maize Streak virus	33.3	16.7	7.9
				Culvularia Leaf Spot	66.7	23.3	15.9
				Corn smut	31.7	11.4	7.1
				Aspergillus ear rot	35.6	12	4
				MLN Disease	22.2	26.7	71.6

3.3. Sorghum Diseases

Prevalence, Incidence and Severity of Sorghum Diseases

Results of the survey indicated that the major Sorghum diseases that prevailed in the study area was include Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum* Pass), Downy Mildew *(Peronosclerospora sorghi)*, Covered kernel Smut *(Sphacelotheca sorghi)* and Loose Smut (*Sporisorium sorghi*). Among these diseases Anthracnose (*Colletotrichum sublineolum*) and Leaf Blight (*Helminthosporium turcicum* Pass) were the major diseases of high prevalence in all nine districts of the study area with high incidence and severity level (Table 2). In all nine districts of the study area the prevalence of sorghum Anthracnose (*Colletotrichum sublineolum*) were 100%. In every farmer's field there was no single sorghum plant which is free of anthracnose. Previously, [27], reported that 55-85% sorghum anthracnose incidence was observed in the altitude range of 1350-2150 m.a.s.l. But, the present results demonstrate that sorghum anthracnose has 100% distribution in the surveyed areas than was earlier thought and confirms that indeed the disease is a major threat to sorghum production in the country.

The prevalence of leaf blight *(Helminthosporium turcicum)* was higher in almost all sorghum growing areas of the Karsa (74.6%), Bure (74.1%), Halu (70.8%), same Seka Chokorsa and Shebe Sombo (69.4%), Bedele (60.4%), Gechi (55.8%) and Matu (37%) districts (Table 2). This study is in line with previous result that leaf blight was among the important diseases in all sorghum growing environments of the country [14].

The overall highest Covered kernel Smut *(Sphacelotheca sorghi)* disease prevalence (51.9%) was recorded in Seka Chokorsa district. This disease wasn't recorded in Bure and Halu districts. Sorghum loose smut (*Sporisorium sorghi*) disease prevalence was not recorded except Karsa, Shebe Sombo and Bedele districts with prevalence of 44.4% 31.7% and 18.5% respectively (Table 2). Sorghum smuts especially, loose, head smut and long smut was the challenging biotic factors to sorghum production in many parts of Ethiopia [44]. Sorghum Downy Mildew *(Peronosclerospora sorghi)* disease was widely distributed in all the surveyed districts and fields at varying levels of disease incidence and severity and cropping season. As results of surveyed areas showed that the sorghum down mildew was observed in almost low lands of Jima zone. The study disagreed with [37, 47] who reported high prevalence of SDM in highlands and wetter areas in Nigeria, Kenya and Uganda [32].

Sorghum Anthracnose *(Colletotrichum sublineolum)* disease incidence was 100% in Bure, Halu, Karsa and Shebe Sombo districts of surveyed fields and the surveyed areas were categorized under high Anthracnose disease incidence (Table 2). As a result, farmers are irritated by the nature and epidemics of the disease during the season. [14] Reported that anthracnose had moderate to severe epidemics in the major sorghum growing areas of Ethiopia. The highest disease incidence (76.3%) of Sorghum Leaf Blight (*Helminthosporium turcicum* Pass) was recorded in Bedele district (Table 2).

The highest Covered kernel Smut *(Sphacelotheca sorghi)* incidence (56.7%) was also recorded in Chora district followed by Bedele districts (47.5%) (Table 2). The incidence of covered kernel smut varies from place to place but in Ethiopia, it was estimated to be about 50% [43, 55]. According to [51] for higher covered smut incidence, optimum temperature of 25 ℃ and half moistened soil during planting are more important than other factors. The use of local cultivars with lower quality might be aggravated the epidemiology of smut. In addition, prevailing weather is another important factor that influences the incidence and severity of plant diseases [35]. The Sorghum loose smut (*Sporisorium sorghi*) incidence was recorded only in three districts of Bedele, Shebe Sombo and Karsa with incidence of 40%, 16.7%, and 6.7% respectively. It was not recorded in Gechi, Chora, Matu, Bure, Halu and Seka Chokorsa districts (Table 2).

Similarly Sorghum Downy Mildew *(Peronosclerospora sorghi)* incidence was recorded only in three districts of Jima Zone. These districts are Seka Chokorsa with incidence of 13.3%, Shebe Sombo with incidence 10% and Karsa with incidence of 6.7%. This disease was not recorded in Buno Bedele and Ilu Aba Bora zones (Table 2).

In Bedele district disease severity was 41.7%, 17.7%, 5% and 25% for Anthracnose, Leaf Blight, Covered smut and loose smut, respectively where as in Gachi district, the severity level of the diseases was 28.3%, 21.7% and 13.3% for Anthracnose, Leaf Blight and Covered Smut. The Severity of Sorghum Anthracnose was high in the survey areas with high temperature. As results of survey showed the severity of Sorghum anthracnose in Jima zone was ranged from 25% in Shebe Sombo to 50.4% in Seka Chokorsa districts. The result of this survey is in line with [13], who also reported that sorghum anthracnose was very severe in Jimma. According to [7, 58], and [31], more intense sorghum anthracnose is associated with high temperature and relative humidity. Similarly, In Chora district disease severity was 18.3% and 6.7% for Anthracnose and Covered smut (Table 2). According to the results of the survey, severity of sorghum anthracnose clearly depends on interactions of favorable weather conditions, cultural practices and susceptibility of sorghum cultivars farmer's they cultivated. During the survey season 46 different sorghum cultivars were recorded at different agro-ecological areas of Southwestern parts of Oromia. This high availability of different sorghum cultivars in this country could play a great role in developing resistant varieties to this disease. The result is in line with, [52] reported that as a center of origin and diversity of sorghum, Ethiopia possesses a very diverse sorghum germplasm. Sorghum leaf blight was causes damage in all sorghum production areas of the surveyed areas even if the amount of damage was not the same as that of anthracnose. This study is in line with previous result that leaf

blight was among the important diseases in all sorghum growing environments of the country [14]. The severity of down mildew was observed only in Jima zone in areas of sorghum production potential. The results of survey showed that the range of sorghum down mildew severity was 3.3% in Karsa to 6.7% in Seka Chokorsa districts of Jima zone. This study is in line with previous result that downy mildew was among the important diseases in all sorghum growing environments of the country [14].

Table 2. *Percentage of Prevalence, Incidence and Severity Index of Sorghum crop diseases surveyed fields.*

Zone	Districts	Elevations (m.a.s.l)	Number of field assessed	Diseases of Major Crops	Disease measurement		
					P%	I%	S%
Buno Bedele	Bedele	1863-1986	9	Anthracnose	100	88.9	41.7
				Leaf Blight	60.4	76.3	17.7
				covered smut	38.3	47.5	5
				Loose smut	31.7	40	25
	Gechi	2074-2244	6	Anthracnose	100	78	28.3
				Leaf Blight	55.8	13.3	21.7
				covered smut	38.3	6.7	13.3
	Chora	1952	1	Anthracnose	100	95	18.3
				covered smut	12	56.7	6.7
Ilu Aba Bora	Matu	1693-1743	2	Anthracnose	100	86	30.1
				Leaf Blight	37	45	20.6
				covered smut	14.8	13.3	6.7
	Bure	1499-1726	8	Anthracnose	100	100	38.3
				Leaf Blight	74.1	31.7	17.2
	Halu	1586-1704	8	Anthracnose	100	100	39.8
				Leaf Blight	70.8	43.8	16.5
Jima	Seka Chokorsa	1798-2003	4	Anthracnose	100	92.5	50.4
				Leaf Blight	69.4	22.5	13.3
				covered smut	51.9	13.3	6.7
				Downy mildew	40.7	13.3	6.7
	Karsa	1684-1779	4	Anthracnose	100	100	28.2
				Leaf Blight	74.6	41.4	17.3
				Downy mildew	14.8	6.7	3.3
				covered smut	25.9	16.7	6.7
				Loose smut	18.5	6.7	3.3
	Shebe Sombo	1337-1667	4	Anthracnose	100	100	25
				Leaf Blight	69.4	40	17.5
				covered smut	29.6	10	6.7
				Downy mildew	28.9	10	6
				Loose smut	44.4	16.7	10

3.4. Tef Diseases

Prevalence, Incidence and Severity of Tef Diseases

As well as the same the survey results, tef crops were very vulnerable due to environmental conditions and lack of disease resistant tef varieties in Jima and Ilu Aba Bor zones. But, over these two zones, Buno Bedele zone were showed little improvement. For these reasons farmers were sow seeds locally called "Tsedey" and it can reach in a few months and pass by when the disease was about to cause damage for tef head smudge disease and in a few places farmers were used improved seed varieties by imagining pass by when the disease was about to cause damage. However, the improved seed varieties sown by these farmers were not resistant to the disease.

Results of the survey indicated that the major Tef diseases that prevailed in the study area was include Tef Leaf rust *(Uromyces eragrustidis Tracy)*, Tef Zonate Eye Spot *(Helminthosporium gigantum)* and Tef head smudge *(Helminthosporium miyakei Nisikado)*. Among the fungal diseases, zonate eye spot (Helminthosporium giganteum), smut, and leaf blast are recent records [9]. Among these diseases Tef Leaf rust were the major diseases of high prevalence in the study area with high incidence and severity level followed by Tef Zonate Eye Spot and Tef head smudge (Table 3). The highest prevalence of Tef Leaf rust (83.8%) was recorded in Gachi district followed by Karsa (80.6%) district. It was zero prevalence in Halu and Bure districts. Similarly, the highest prevalence of Tef Zonate Eye Spot was recorded in Gechi district with prevalence of 72.5% followed by Chora (68.1%) district (Table 3). It was zero prevalence in Seka Chokorsa, Halu and Bure districts. The highest prevalence of Tef head smudge was recorded in Bedele district with the prevalence of 63% (Table 3). [9] study showed that tef leaf rust and head smudge are widely distributed in farmer's field.

Table 3. *Percentage of Prevalence, Incidence and Severity Index of Tef crop diseases surveyed fields.*

Zone	Districts	Elevations (m.a.s.l)	Number of field assessed	Diseases of Major Crops	Disease measurement		
					P%	I%	S%
Buno Bedele	Bedele	1857-1960	10	Head Smudge	63	40	8.9
				Leaf rust	72.5	39.2	22.6
				Zonate Eye Spot	65.4	40	15.6
	Gechi	2064-2144	5	Head Smudge	41.7	26.7	4.4
				Leaf rust	83.8	37.5	2.7
				Zonate Eye Spot	72.5	55	1.8
Ilu Aba Bora	Chora	1886-1970	10	Head Smudge	55.6	27.5	10
				Leaf rust	72.8	37	19.3
				Zonate Eye Spot	68.1	18.8	21.3
	Matu	1704-1713	4	Leaf rust	63.9	40	18.3
				Zonate Eye Spot	38.9	22.5	8.3
Jima	Seka Chokorsa	1832-2055	4	Head Smudge	55.6	25	15
				Leaf rust	61.1	37.5	16.3
	Karsa	1715-1764	5	Leaf rust	80.6	62.5	14.2
				Zonate Eye Spot	66.7	50	18
	Shebe Sombo	1433-1667	3	Head Smudge	55.6	36.7	10
				Leaf rust	70.4	53.3	18.9
				Zonate Eye Spot	61.1	32.5	18.3

As our survey results was suggested Tef Leaf rust prevalence took precedence, the incidence of Tef Leaf rust preceded and followed by Tef Zonate Eye Spot and Tef head smudge. Head smudge of tef is common disease in warm-humid areas

and can affect the yield and quality of tef. Head smudge incidence is high at valley bottoms near rivers and in fields bordered by shade trees. It is both seed and stubble-borne disease [20]. Date of sowing was own influence on the incidence of the head smudge disease. Comparing to early planted tef, disease was seriously affected the late planted ones. The highest Tef Leaf rust disease incidence was 62.5% in Karsa district followed by Shebe Sombo (53.3%) district (Table 3). The highest Tef Zonate Eye Spot incidence (55%) was also recorded in Gachi followed by Karsa (50%) district. It was zero incidences in Bure, Halu and Seka Chokorsa districts. Similarly, the highest Tef head smudge incidence (40%) was recorded in Bedele district followed by Shebe Sombo (36.7%) district. It was not recorded in Karsa, Matu, Bure and Halu districts (Table 3). The problem of disease was serious in the southwestern parts of Ethiopia where there was high rainfall, and hot and humid climate. Poor genetic potential of the cultivars under wide spread production and the problems of diseases were the major causes for yield reduction of tef. The extent of the problem of low productivity due to these constraints were varies from place to place within the country. The productivity of tef at Southwestern Ethiopia was below 1ton ha^{-1} [54].

Results of the survey indicated that the highest Tef head smudge diseases severity were recorded in Seka Chokorsa (15%) district followed by Shebe Sombo, Bure, Matu and Chora districts of Surveyed areas with 10% respectively. The lowest severity of tef head smudge disease was recorded in Halu and Gachi with 4.4% respectively. However, the lowest severity of head smudge disease was recorded in Oromia region with the mean severity value of 8.6% [48]. Tef head smudge caused by *Helminthosporium myaikai Nisikado* is one of the most serious fungal diseases threatening tef production in southwestern Ethiopia. It attacks the inflorescence of tef plants and a dense mate of dark brown fungus spores cover the infected spikelet's [50].

Tef leaf rust was also other tef disease in southwestern parts of surveyed areas. The highest severity of leaf rust was recorded in Bedele district (22.6%) followed by Chora (19.3%) district. The lowest severity of leaf rust was recorded in Halu and Gachi districts with 2.7% severity. The severity of leaf rust was observed in all surveyed areas of southwestern Oromia on all tef varieties. No complete resistance is yet available for tef rust (*Uromyces eragrostidis Tracy*), another disease with broad distribution in Ethiopia [26, 10]. The amount of yield losses caused by tef leaf rust under farmers' field condition is not known. However, under on-station conditions tef yield losses vary between 10 and 24% [24]. [17] also reported that tef leaf rust cause annual yield loss of 10-41%. Different studies in the past indicated that there is no tef germplasm that showed complete resistant for tef leaf rust. Diseases like tef leaf rust, head smudge, damping off, Zonate eyespot and smut diseases are becoming very important diseases due to agronomic improvement of tef crops and climate change. Except tef head smudge other diseases were not a serious problem in surveyed areas of southwestern Oromia. In the major tef-growing areas of Ethiopia tef suffers less from diseases than most other cereal crops in the major production areas of Ethiopia [53]. According to [12], rust causes an average loss of 10-25%.

4. Conclusion

The results of survey conducted in three Zones and 9 districts of the Southwestern part of Oromia in 2020 to 2022 has enabled to document various diseases that occur on the three major cereal crops: maize, sorghum and Tef. A total of 13 major diseases were recorded across six districts on three major cereal crops. The maximum incidence, severity and prevalence of some of the diseases were based on the nature of the diseases. This study indicates the presence of multiple diseases at different growth stage of the Maize, Sorghum and Tef cereal crops, at different locations and altitude during the assessment. During the assessment different pathogens attacking those cereal crops varieties were observed across surveyed areas. Among all fungal diseases reported, tef leaf rust, head smudge and zonate eye spot are major tef diseases that were observed in surveyed areas. Major maize diseases that prevailed in the study areas were include Turcicum Leaf Blight (*Exserohilum turcicum*), Gray Leaf Spot (*Cercospora zeae-maydis*), Culvularia Leaf Spot, Maize Lethal Necrosis Disease, Aspergillus ear rot, Maize Streak Virus and Corn Smut (*Ustilago maydis*). Major diseases of sorghum were Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum* Pass), Downy Mildew *(Peronosclerospora sorghi)*, Covered kernel Smut *(Sphacelotheca sorghi)* and Loose Smut (*Sporisorium sorghi*) which could be considered as quite important because of high severity level. Results from tef diseases surveyed in three zones reveals that tef leaf rust was prevalent and followed by zonate eye spot and tef head smudge encountered during the survey seasons with varying degree of incidence and severity. Turcicum Leaf Blight and Gray Leaf Spot were prevalent from Maize crop and Anthracnose and Leaf Blight were prevalent from sorghum crop of surveyed in three zones. The incidence and severity of those diseases were increasing from year to year. According to the results of survey were showed, the incidence and severity of tef head smudge in all tef production districts starting from maturity stage. The long and medium maturing local cultivars were found susceptible compared to the early maturing improved varieties. The incidence and severity of Turcicum Leaf Blight and Gray Leaf Spot were increased on the many varieties of maize almost all varieties on which weren't showed the previous surveying season. The severity of maize common smut was increased in all maize production areas. Therefore, efforts should be made towards the integration of multiple disease control options. Varietal modification is also another concern to minimize the effect of those cereal crops diseases. This study indicates that there was no the use of fungicide to control those diseases. Currently,

the disease was becoming severe and using and evaluation of different fungicides for different cereal crops may be an option to control those cereal diseases. The other concern is screening of germplasm to those diseases and selecting those tolerant lines and incorporating in breeding program will also another option to control those diseases in the future. Use of intercropping and crop rotation is needed to minimize the development of those diseases especially for maize and sorghum crops. Hence, the information obtained from this survey result gives some evidence on the importance research intervention in the area particularly by developing or adopting integrated disease management options for those recorded major diseases of the cereal crops in the surveyed areas for sustainable cereal crops production.

1. Generally, farmers are responsible for growing and harvesting cereal crops, as well as managing their farms and resources, use resistant variety. They also need to adopt and implement sustainable farming practices that can prevent and control cereal crop diseases, such as crop rotation and intercropping with non-cereal crops, such as legumes and oilseeds, pest management, and soil conservation.
2. Researchers are responsible for conducting scientific studies on the causes, prevention, and management of cereal crop diseases. They also develop new varieties, technologies, and practices that can improve the resistance and productivity of cereal crops.
3. Agricultural offices are responsible for providing technical guidance and support to farmers on how to grow healthy and profitable cereal crops. They also monitor and inspect the crop conditions, diagnose and treat diseases, and enforce the relevant regulations and standards.
4. Government is responsible for creating and implementing policies and programs that can promote the development and sustainability of the cereal crop sector. They also provide funding, infrastructure, and incentives for research and extension activities, as well as ensuring food security and safety.
5. Extension office is responsible for facilitating the transfer of knowledge and innovation from research to farmers. They also provide training, education, and advisory services to farmers on how to adopt and apply the best practices and technologies for cereal crop production.

Abbreviations

BeARC	Bedele Agricultural Research Ceneter
OARI	Oromia Agricultural Research Institute
BH	Bako Hybrid
m.a.s.l	meter above sea level
P	Prevalence
I	Incidence
S	Severity

Acknowledgments

The authors acknowledge all the respondents participated in this survey and thank the Oromia Agricultural Research Institute (OARI) for their financial support. We also express our thanks to our Research center the Bedele Agricultural Research Center (BeARC) for Providing vehicle and facilities during this activity. Again we like to thanks to Buno Bedele, Jima and Ilu Aba Bor zones and with their districts of Agricultural offices for facilitating the successful completion of this activity.

Author Contributions

Takele Kusa: Conceptualization, Data curation, Formal Analysis, Methodology, Project administration, Software, Supervision, Writing – original draft, Writing – review & editing

Latera Dore: Conceptualization, Methodology

Jara Regassa: Conceptualization, Visualization

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Adipala, E., Lipps, P. E. and Madden, L. V., 1993. Occurrence of Exserohilum turcicum on maize in Uganda. *Plant disease*, *77*(2), pp. 202-205.

[2] Alegbejo, M. D., Olojede, S. O., Kashina, B. D. and Abo, M. E., 2002. Maize streak mastrevirus in Africa: distribution, transmission, epidemiology, economic significance and management strategies. *Journal of Sustainable Agriculture*, *19*(4), pp. 35-45.

[3] Alemu, L., Adane A., Berahanu B., and Mesfin T., 1997. Identification of viruses from maize and grass hosts. *Pest Managment Journal of Ethiopia*, *1*(1 & 2), pp. 73-76.

[4] Alemu, N., Fikre, L. and Gezahegn, B., 2016. Distribution and importance of maize grey leaf spot Cercospora zeae-maydis (Tehon and Daniels) in south and southwest Ethiopia. *J Plant Pathol Microbiol*, *7*(362), p. 2.

[5] Ali, M. E. K., Warren, H. L., 1987. Physiological races of Colletotrichum graminicola on sorghum. Plant Dis., 71: 402-404.

[6] Aschalew, S., Fekede, A. and Kedir, W., 2012. Influence of cultural practices on the development of gray leaf spot (GLS) on maize at Bako, Western Ethiopia. *International Journal of Phytopathology*, *1*(1), pp. 19-26.

[7] Ashenafi, G., Kebebew, A., Yazachew, G. and Tsion, F., 2018. Status of Tef (Eragrostis tef) diseases in Ethiopia. *Agricultural Research & Technology: Open Access Journal*, *17*(3).

[8] Badebo, A. 2013. *Achievements and Prospects of Tef Improvement-Proceedings of the Second International Workshop, November 7-9, 2011, Debre Zeit, Ethiopia*. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia; Institute of Plant Sciences, University of Bern, Switzerland, pp 171-192.

[9] Cabanas, D., Watanabe, S., Higashi, C. H. V. and Bressan, A., 2013. Dissecting the mode of maize chlorotic mottle virus transmission (Tombusviridae: Machlomovirus) by Frankliniella williamsi (Thysanoptera: Thripidae). *Journal of economic entomology*, *106*(1), pp. 16-24.

[10] Castellani, E. and Ciccarone, A., 1939. Malattie crittigamiche del'teff'(Fun-gal disease of'teff'). *Regio Inst. Agron. Afr. Ital.(Rev. Appl. Mycol. 19: 84. 1940)*.

[11] Chala, A., Brurberg, M. B. and Tronsmo, A., 2007. Prevalence and intensity of sorghum anthracnose in Ethiopia. *Journal of SAT Agricultural Research 5*(1).

[12] Chala, A., Brurberg, M. B. and Tronsmo, A. M., 2010. Incidence and severity of sorghum anthracnose in Ethiopia. *Plant Pathology Journal (Faisalabad)*, *9*(1), pp. 23-30.

[13] CSA (Central Statistical Agency), 2016. Annual Agricultural sample survey, area and production of major crops (Private Peasant Holdings, Meher Season). AddisAbaba, Ethiopia.

[14] Dagne, W., Fekede, A., Legesse, W. and Gemechu, K., 2001. Grey leaf spot disease: a potential threat to maize production in Ethiopia. *Sebil (Ethiopia)*, *9*, 22-23 June 1999, Addis Ababa Ethiopia, pp 147-157.

[15] Dawit, W. and Andnew, Y., 2005. The study of fungicides application and sowing date, resistance, and maturity of Eragrostis tef for the management of teff rust [Uromyces eragrostidis]. *Canadian journal of plant pathology*, *27*(4), pp. 521-527.

[16] Dean, R., Van Kan, J. A., Pretorius, Z. A., Hammond‐Kosack, K. E., Di Pietro, A., Spanu, P. D., Rudd, J. J., Dickman, M., Kahmann, R., Ellis, J. and Foster, G. D., 2012. The Top 10 fungal pathogens in molecular plant pathology. *Molecular plant pathology*, *13*(4), pp. 414-430.

[17] Degaga, J. and Angasu, B., 2017. Assessment of indigenous knowledge of smallholder farmers on intercropping practices in west Hararghe Zone; Oromia National Regional State, Ethiopia. *Journal of Agricultural Economics and Rural Development*, *3*(3), pp. 270-278.

[18] Degete, A. G., 2021. Major tef diseases in Ehtiopia and their management. *Int J Res Stud Agric Sci*, *7*, pp. 31-37.

[19] Dhami, N. B., Kim, S. K., Paudel, A., Shrestha, J. and Rijal, T. R., 2015. A review on threat of gray leaf spot disease of maize in Asia. *Journal of Maize Research and Development*, *1*(1), pp. 71-85.

[20] Doehlemann, G., Ökmen, B., Zhu, W. and Sharon, A., 2017. Plant pathogenic fungi. *Microbiology spectrum*, *5*(1), pp. 5-1.

[21] Duan, C., Qin, Z., Yang, Z., Li, W., Sun, S., Zhu, Z. and Wang, X., 2016. Identification of pathogenic Fusarium spp. causing maize ear rot and potential mycotoxin production in China. *Toxins*, *8*(6), p. 186.

[22] DZARC, 2002. Debre Zeit Agricultural Research Center), *Annual Research report for the period* 2000/2001. Debre Zeit, Ethiopia.

[23] Galicia-Garcı́a, P. R., Silva-Rojas, H. V., Mendoza-Onofre, L. E., Zavaleta-Mancera, H. A., Córdova-Téllez, L. and Espinosa-Calderón, A., 2016. Selection of aggressive pathogenic and solopathogenic strains of Ustilago maydis to improve Huitlacoche production. *Acta Botanica Brasilica*, *30*, pp. 683-692.

[24] Gemechu, A., Assefa, K., Genet, Y. and Fikre, T., 2018. Status of Tef (Eragrostis tef) diseases in Ethiopia. *Agricultural Research & Technology: Open Access Journal*, *17*(3).

[25] Girma, T., A. Fekede, H. Temam, T. Tewabech and B. Eshetu et al., 2009. Review of Maize, Sorghum and Millet Pathology Research. In: Increasing Crop Production through Improved Plant Protection-Volume II, Tadesse, A. (Ed.). *PPSE and EIAR*, Addis Ababa, Ethiopia, pp: 245-301.

[26] Guadie, D., Abraham, A., Tesfaye, K., Winter, S., Menzel, W. and Knierim, D., 2018. First report of maize yellow mosaic virus infecting maize (Zea mays) in Ethiopia. *Plant Disease*, *102*(5), pp. 1044-1044.

[27] Guadie, D., Tesfaye, K., Knierim, D., Winter, S. and Abraham, A., 2019. Molecular analysis of maize (Zea mays L.)-infecting mastreviruses in Ethiopia reveals marked diversity of virus genomes and a novel species. *Virus genes*, *55*, pp. 339-345.

[28] Harlapur, S. I., Mruthunjaya, C. W., Anahosur, K. H. and Muralikrishna, S., 2000. A report survey and surveillance of maize diseases in North Karnataka. *Karnataka Journal of Agricultural Sciences*, *13*(3), pp. 750-751.

[29] Hess, D. E., Bandyopadhyay, R., Sissoko, I., 2002. Pattern analysis of sorghum genotype H environment interaction for leaf, panicle and grain anthracnose in Mali. Plant Dis., 86, 1374-1382.

[30] Hulluka, M. and Esele, J. P. E., 1992. Sorghum diseases in eastern Africa. *Sorghum and millets diseases: a second world review*, *502*(324), p. 21.

[31] IITA (International Institute of Tropical Agriculture), 1989. Maize production manual, IITA, Ibadan, Nigeria. 45 – 47pp.

[32] Jakhar, D. S., Singh, R., Kumar, S., Singh, P. and Ojha, V., 2017. Turcicum leaf blight: A ubiquitous foliar disease of maize (Zea mays L.). *International Journal of Current Microbiology and Applied Sciences*, *6*(3), pp. 825-831.

[33] Kranz, J. and J. Rotem, 1987. Experimental Techniques in Plant Disease Epidemiology. Springer-Verlag, Berlin, pp. 299.

[34] Kumar, M. P., Narayan Reddy, P., Ranga Reddy, R. and Suresh Babu, C., 2017. Effect of Spacing and Dosage of Nitrogen on Turcicum Leaf Blight Disease Incidence on Maize. *International Journal of Pure and Applied Biosciences*, *5*(4), pp. 1273-1276.

[35] Kutama, A. S., Bashir, B. and James, D., 2010. Incidence of sorghum diseases in dawakin-kudu local government area, kano state, Nigeria. *Afri J. Gen. Agri*, *6*(4), pp. 307-313.

[36] Kyetere, D. T., Ming, R., McMullen, M. D., Pratt, R. C., Brewbaker, J. and Musket, T., 1999. Genetic analysis of tolerance to maize streak virus in maize. *Genome*, *42*(1), pp. 20-26.

[37] Lagat, M., Danson, J., Kimani, M. and Kuria, A., 2008. Quantitative trait loci for resistance to maize streak virus disease in maize genotypes used in hybrid development. *African Journal of Biotechnology*, *7*(15).

[38] Madrid, A. J., Klass, T., Roman-Reyna, V., Jacobs, J. and Ivey, M. L., 2021. Draft Genome Sequences of Four Streptomycin-Sensitive Erwinia amylovora Strains Isolated from Commercial Apple Orchards in Ohio. *Microbiology Resource Announcements*, *10*(50).

[39] Mahuku, G., Wangai, A., Sadessa, K., Teklewold, A., Gissa, D. W., Ayalneh, D., Adams, I., Smith, J., Bottomley, E., Bryce, S. and Braidwood, L., 2015. First report of maize chlorotic mottle virus and maize lethal necrosis on maize in Ethiopia. Plant Disease 99(12).

[40] McKevith, B., 2004. Nutritional aspects of cereals. *Nutrition Bulletin*, *29*(2), pp. 111-142.

[41] Mengistu, H., 1982. Diseases of sorghum at some locations in Ethiopia. *Ethiopian J Agric Sci*, *4*(1), pp. 45-53.

[42] Merkuz, A. and Getachew, A., 2012. Evaluation of improved and local/landrace/sorghum varieties for covered kernel smut. *Archives of phytopathology and plant protection*, *45*(6), pp. 717-723.

[43] Misgana, M., Yesuf, E. and Awoke, T., 2015. Evaluation of maize variety for ear rot (Fusarium graminearum) in South Omo zone of Ethiopia. *Academia journal of agricultural research*, *3*(9), pp. 195-197.

[44] MoFED, 2018. Annual Progress Report of the GTP II; Ministry of Finance and Economic Development: Addis Ababa, Ethiopia, 2018; pp. 1–33.

[45] Ngugi, H. K., King, S. B., Abayo, G. O. and Reddy, Y. V. R., 2002. Prevalence, incidence, and severity of sorghum diseases in western Kenya. *Plant Disease*, *86*(1), pp. 65-70.

[46] Peterson, R. F., Campbell, A. B. and Hannah, A. E., 1948. A diagrammatic scale for estimating rust intensity on leaves and stems of cereals. *Canadian journal of research*, *26*(5), pp. 496-500.

[47] Ramathani, I., Biruma, M., Martin, T., Dixelius, C. and Okori, P., 2011. Disease severity, incidence and races of Setosphaeria turcica on sorghum in Uganda. *European Journal of Plant Pathology*, *131*, pp. 383-392.

[48] Sewalem, A., Zerihun, K. and Eshetu B., 2001. Tef pathology research in Ethiopia. *Debre Zeit, Ethiopia Agricultural Research Organization*, EARO. pp. 215-222.

[49] Sisay, A., Abebe, F. and Wako, K., 2012. Evaluation of three potential botanicals against sorghum covered smut (Sphacelotheca sorghi) at Bako, Western Oromia Ethiopia. *African Journal of Plant Science*, *6*(8), pp. 226-231.

[50] Sleper, D. A., and Poehlman, J. M., 2006. Breeding field crops. 5 th Edn., Whily-Blackwell Publ., USA. Pp 424.

[51] Stewart, R. B. and Dagnachew, Y., 1967. Index of plant disease in Ethiopia. Haile Selassie I University, College of Agric., Debre Zeit. *Bulletin*, *50*.

[52] Tegegn, M., Sera, L. and Merra, T. M., 2020. Factors affecting profitability of insurance companies in Ethiopia: panel evidence. *International Journal of Commerce and Finance*, *6*(1), pp. 1-14.

[53] Teklemariam, W., Tulu, A. and Tessera, M., 1985, February. A review of research on oil crop disease in Ethiopia. In *proceeding of first crop protection symposium* (pp. 4-7).

[54] Tewabech, T., Dagne, W., Girma, D., Meseret, N., Solomon, A. and Habte J., 2012. Maize pathology research in Ethiopia in the 2000s: A review. In *Meeting the Challenges of Global Climate Change and Food Security through Innovative Maize Research* (p. 193).

[55] Tewabech, T., Getachew, A., Fekede, A. and Dagne, W., 2001. Maize pathology research in Ethiopia: A review. In *Enhancing the Contribution of Maize to Food Security in Ethiopia: Proceedings of the Second National Maize Workshop of Ethiopia: 12-16 November 2001, Addis Ababa, Ethiopia* (p. 97). CIMMYT.

[56] Thomas, M. D., 1992. Sorghum Diseases in Western Africa. In: Sorghum and Millet Diseases: A Second World Review, De Milliano, W. A. J., R. A. Frederiksen and G. D. Bengston (Eds.). International Crop Research Institute for the Semi-Arid Tropics, Patancheru, India, pp: 25-29.

[57] Tilahun, T., Wagary, D., Demissie, G., Negash, M., Admassu, S. and Jifar, H., 2012. Maize pathology research in Ethiopia in the 2000s: A review. In *Meeting the Challenges of Global Climate Change and Food Security through Innovative Maize Research* (p. 193).

[58] Vivek, B., Bänziger, M. and Pixley, K. V., 2005. Characterization of maize germplasm grown in eastern and southern Africa: Results of the 2004 regional trials coordinated by CIMMYT.

[59] Wolf, E. D., 2002. Field crop disease facts. *Gray leaf spot. College of Agricultural and cooperative extension, PENN STATE*.

[60] Zhao, M., Ho, H., Wu, Y., He, Y. and Li, M., 2014. Western Flower Thrips (F rankliniella occidentalis) Transmits M aize Chlorotic Mottle Virus. *Journal of Phytopathology*, *162*(7-8), pp. 532-536.

Biography

Takele Kusa is a Researcher at Bedele Agricultural Research Center, Crop Protection Process. He completed his M.Sc in Agronomy from Wallaga University in 2024, and his B.Sc of Plant Science from the same institution in 2019. He currently serves at Bedele Agricultural Research Center as Researcher of Plant Pathology and Weed Science.

Research Field

Takele Kusa: Bedele, Chora, Gachi, Matu, Bure, Halu, Seka Chokorsa, Karsa and Shebe Sombo

Latera Dore: Bedele, Chora, Gachi, Matu, Bure, Halu, Seka Chokorsa, Karsa and Shebe Sombo

Jara Regassa: Bedele, Chora, Gachi, Matu, Bure, Halu, Seka Chokorsa, Karsa and Shebe Sombo