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Survey of distribution and status of major cereal crop disease in West Shoa, Horro Guduru Wollega and East Wollega Zones, Ethiopia

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Abstract
A field survey was conducted to assess diseases of five important cereal crops i.e Maize, wheat, sorghum, barley and rice in parts of Western Oromia: West Shoa, Horro Guduru Wollega, East Wollega and Buno Bedele Zones during 2019 and 2020 main cropping season, covering 121 farms altogether. Prevalence, incidence and severity of each disese were scored. Diseases recorded on maize include Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum Pass*), Zonate Spot (*Gloeocercospora sorghi*) and Loos Smut (*Sporisorium sorghi*). Major diseases recorded on sorghum include Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum Pass*), Zonate Spot (*Gloeocercospora sorghi*) and Loos Smut (*Sporisorium sorghi*). Though many common diseases were scored on wheat, two of them - Septoria Leaf Blotches (*Septoria tritici spps*) and Fusarium Head Blight (*Fusarium graminearum spps*) appeared to be economically the most important ones. Three diseases i.e Brown spot Brown spot (*Cochlidolus miyabeanus*), Blast (*Magnaporthe oryzae*) and Bacterial Blight (*Xanthomonas oryzae pv.* oryzae) were recorded on rice in Chawaka district where as only net blotch appeared to be economically important for barley.

Keywords: Distribution, status, major Cereal disease, Prevalence, Severity

1. Introduction

Agriculture is vital in supporting sustainable rural livelihoods and economic growth for most of Africa's growing population. Between 20 - 30% of GDP and 55% of the total value of African exports comes from the agricultural sector (World Bank, 2008) [11]. However, there has been a decreased trend in per capita food production in Africa over the years. Between 1970 and 2007, there was a reduction of 30% in per capita food production in Eastern Africa, 20% in Southern Africa, 2% in Western Africa, and 40% in Central Africa (USDA, 2010) [9]. In comparison, per capital, food production has increased by 35% in South Asia (Lal, 2015) [5].

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 (Degaga and Angasu, 2017). Ethiopia has diverse agro-ecology that permits different agricultural systems and production of different crops. The existence of this diverse agro-ecology together with diverse farming systems, socio-economic, cultures and climate zones provided Ethiopia with various biological wealth of plants, animals, and microbial species, especially crop diversity (Atnaf *et al*., 2015).

Cereal crops are plants belonging to the grass family Poaceae that are grown and harvested primarily for their edible grain (McKevith *et al*., 2004) [6]. 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. However, many cereals can also be used to feed livestock and their utility is further enhanced by their capacity for long term storage (McKevith *et al*., 2004) [6]. Food and Agriculture Organization of the United Nations estimates that2609 million tonnes of cereal crops were produced in 2018 (FAO, 2019) [4].

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 (CSA, 2016; MoFED, 2018) [7]. Moreover, the average national productivity of cereals such as maize, wheat, teff, 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 (Dean *et al.*, 2012) [2]. 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 (Dean *et al.*, 2012; Doehlemann *et al.*, 2017) [2, 3]. 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 determine relative occurrence, distribution and status of major cereals' diseases in parts of western Oromia.

Materials and Methods

Description of the study area

The field survey was conducted in West Shoa, Horro Guduru Wollega, East Wollega and Buno Bedele Zones during 2019 and 2020 main cropping season. Disease assessment survey was conducted in two districts of West Shoa Zone Chalia and Ilu galan Districts; two districts of Horro Guduru Wollega Zone: Guduru and Horro Districts; in five districts of East Wollega Zone namely Gida Ayaana, Guto Gida, Sibu Sore, Jima Arjo and Diga Districts; and Chewaka District of Buno Bedelle Zone (Table 1).

The disease survey was conducted to assess the prevalence, incidence and severity of major cereal crops: maize, wheat, barley, Sorghum and rice. In most of the areas, the survey was conducted during dough crop growth stage. The survey was conducted from 20th to 27th September for low land; from 16th to 23rd October for mid land; and from 5th to 12th November for highland areas. The annual mean minimum and maximum temperature of the area is 120C and 27.40C, respectively, while the annual rainfall is 1415.2 mm. The geographical locations of the surveyed areas were in the range of latitude and longitude of $08^0$34.70'- $09^0$40.41'N and $036^0$06.47'-$037^0$29.30'E, respectively.

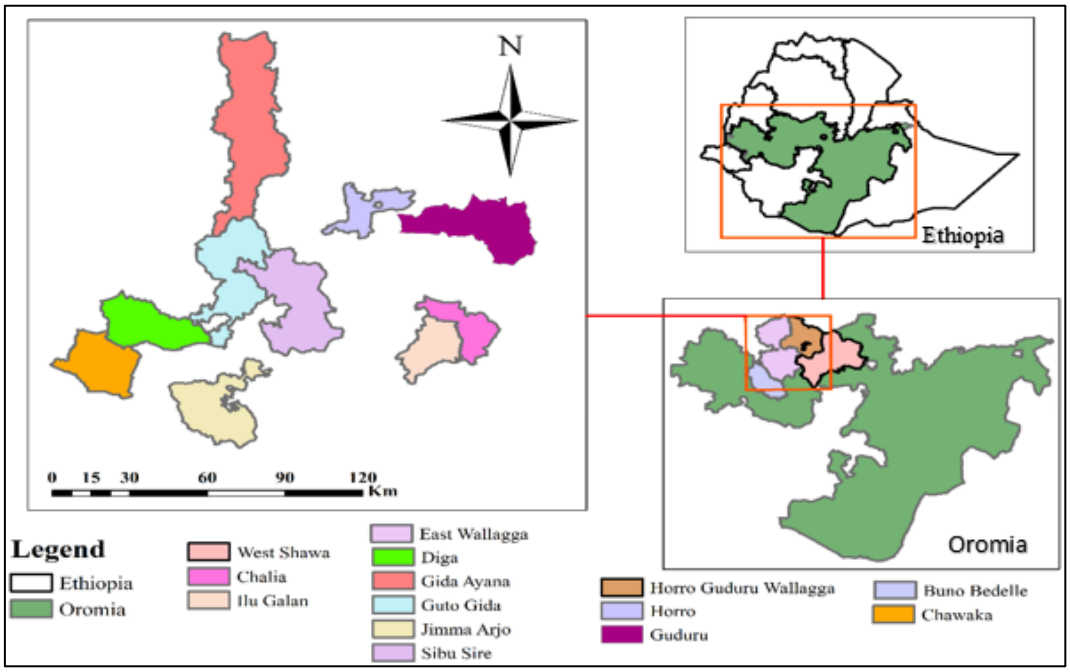

Fig 1: Map of site

Field survey

The survey was conducted in 54 Kebeles and 121 fields in the ten districts of the four zones. Purposive sampling technique was applied in the survey. 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 crop was: Maize 55 samples, Sorghum 14 samples, Wheat 23 samples, Barley 19 samples and Rice 10 samples (Table 1). The locations between successive samples of same crop (between maize and maize, between wheat and wheat) were at least 4-6 km apart depending on the topography and the relative importance of the crop within each location. The disease assessment was made along the two diagonals (in an "X" pattern) of the field from five points using 1m × 1m (1 m^2) quadrates from small cereals and 2m × 2m (4 m^2) quadrates for maize and sorghum.

Questioner was prepared to interview farmers on issues like variety grown, preceding 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.

Table 1: Characteristic features of surveyed Cereal fields in four Zones in Western Oromia

Zone	Districts	Crops	Altitude (m.a.s.l)	No. field assessed
West Shoa	Ilu Galan	Maize	1711-1874	9
	Chalia	Wheat	2485-2630	7
		Barley	2435-2632	6
		Mean	1711-2632	22
H/G/Wollega	Guduru	Maize	2286-2396	9
		Wheat	2315-2446	8
		Barley	2292-2349	7
	Horro	Wheat	2451-2757	8
		Barley	2350-2751	6
		Mean	2286-2757	38
East Wollega	Gida Ayyana	Maize	1290-2469	9
	Guto Gida	Maize	1333-1379	7
	Sibu Sire	Maize	1744-1841	7
	Jima Arjo	Maize	2170-2345	6
	Diga	Sorghum	2113-2286	6
		Mean	1290-2469	35
Buno Bedelle	Chawaka	Maize	1231-1291	8
		Sorghum	1204-1256	8
		Rice	1202-1265	10
		Mean	1202-1265	26
		Over all of mean	1202-2757	121

m.a.s.l= meters above sea level

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.

Disease prevalence

Disease prevalence was calculated using the formula:

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

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. The formula for determination of incidence is:

$$\text{Disease Incidence (\%)} = \frac{\text{Number of Diseased plants in the sample}}{\text{Total number of plant in the quardate}} \times 100$$

Disease Severity

The level of disease severity for each field was determined by using visual disease rating scale as given by (Wheeler, 1969):

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

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.

Results and Discussion

Status and distribution of cereal diseases

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.

Maize diseases

Maize disease prevalence

Results of the survey indicated that the major maize diseases that prevailed in the study area include Turcicum Leaf Blight (*Exserohilum turcicum*), Eyespot (*Kabatiella zeae*), Phaeosphaeria Leaf Spot (*Phaeosphaeria maydis*), Gray Leaf Spot (*Cercospora zeae-maydis*), Culvularia Leaf Spot (*Curvularia pallescens*), Brown Sport (*Physoderma maydis*), Maize Streak Virus and Common Smut (*Ustilago maydis*).These diseases were highly prevalent with high level of incidence and severity particularly in the six districts of the four zones. Maize Streak Virus and Maize Common Smut were observed to be apparently less important (minor) in most districts. The prevalence of major maize diseases in the study area is indicated in Table 2.

Prevalence of maize Turcicum Leaf Blight was 100% in all the surveyed districts. Likewise, Gray Leaf Spot was 100% prevalent in Ilu Galan, Guduru and Jima Arjo districts but in Gida Ayyana its prevalence was 83.33%. In Guto Gida and Chewaka districts, Gray Leaf spot was 80% prevalent. The prevalence of Phaeosphaeria Leaf Spot was found to be 100% in Ilu Galan, Sibu Sire and Jima Arjo Districts. Maize Culvularia Leaf Spot prevalence in Guto Gida was 100%; it was 83.3% prevalent in Gida Ayyana and Chewaka while the prevalence was 80% in Jima Arjo district. Maize Eyespot disease was 100% prevalent in Guto Gida and Sibu Sire districts while it was 80% prevalent in Chewaka district. Maize Brown Spot disease was 100% prevalent in Jima Arjo

while it was 80% prevalent in Gida Ayyana District.

Maize disease incidence

Incidence of Turcicum Leaf Blight generally ranged from 81.25% - 100%. The maximum Turcicum Leaf Blight incidence of 100 % was recorded in Jima Arjo district followed by Guduru and Guto Gida where the disease prevailed 94% and 91%, respectively (Table 2). Therefore, all the surveyed areas in this study could be categorized under high Turcicum Leaf Blight incidence. Incidence of Maize Gray Leaf Spot and Phaeosphaeria Leaf Spot ranged between 51.5% - 100% and 26.5%-100%, respectively (Table 2).

The maximum Gray Leaf Spot and Phaeosphaeria Leaf Spot incidence was recorded in Jima Arjo district while the minimum incidences of the two diseases were recorded in Gida Ayyana district. Maize Culvularia Leaf Spot had its highest incidence of 100% in Guto Gida followed by Chewaka, Sibu Sira and Jimma Arjo with incidence of 94%, 90% and 85%, respectively where as its lowest incidence of 30% was recorded in Ilu Galan; other districts have incidence values that lie in between. The highest Brown Spot incidence of 80% was recorded in Gida Ayyana followed by 66% and 62% in Jimma Arjo and Guto Gida, respectively; it was not incident, however, in Ilu Galan, Guduru and Sibu Sire districts.

Maize disease severity

In terms of Turcicum Leaf Blight severity, the most affected fields were found in Sibu Sire with 55.5% disease severity, followed by Guto Gida and Jima Arjo districts with 45.8% and 41.5% severity levels, respectively. On the other hand, the minimum severity of 34.5% was noticed in Guduru district. The survey result revealed that Turcicum Leaf Blight of maize was prevalent in major maize growing districts with the severity level ranging from 34.5 to 55.55% (Table 2).

The maximum Phaeosphaeria Leaf Spot severity of 38% was observed in Sibu Sire followed by 31.33% in Guduru district and the minimum severity was 8.67% noticed in Guto Gida district. The survey result revealed that Gray Leaf Spot of maize was prevalent in all the maize growing surveyed districts in low to severe form with severity ranging from 11.4% in Guduru to 37.4%Chawaka district. Culvularia Leaf Spot of maize was prevalent in all the surveyed districts with severity level ranging from 11% in Ilu Galan to 25% in Jimma Arjo district.

The severity of Brown Spot ranged from 13.5 -30% in Guto Gidda, Gidda Ayyana, Chawaka and Jimma Arjo districts where as its severity was virtually zero in Ilu Galan, Guduru and Sibu Sire districts. The severity of Eyespot ranged from 11.5% in Guto Gida to 21% in Guduru district; in Jimma Arjo Eyespot severity was virtually zero. From the surveyed districts, Maize Streak Virus disease severity of 15%, 14.33% and 10.83% was recorded in Gida Ayyana, Guto Gida and Chawaka districts, respectively. Similarly, Maize Common Smut severity of 15% was recorded in Guto Gida District (Table 2).

Table 2: Percentage of Prevalence, Incidence and Severity Index of Maize disease surveyed fields

Zones	Districts	Types Of Disease	Prevalence %	Incidence %	Severity %
West Shoa	Ilu Galan	Turcicum Leaf Blight	100	86.6	36.6
		Eyespot	60	30	18.33
		Phaeosphaeria Leaf Spot	100	56.6	10.64
		Gray Leaf Spot	100	55.2	14
		Brown Sport	0	0	0
		Culvularia Leaf Spot	40	30	11
H/G/Wollega	Guduru	Turcicum Leaf Blight	100	94	34.8
		Eyespot	57	72	21
		Phaeosphaeria Leaf Spot	60	90	31.33
		Brown Spot	0	0	0
		Gray Leaf Spot	100	85	11.4
		Culvularia Leaf Spot	47	66	19
East Wollega	Gida Ayyana	Turcicum Leaf Blight	100	84.5	37.5
		Eyespot	33.33	100	16
		Phaeosphaeria Leaf Spot	66.67	26.5	27.5
		Gray Leaf Spot	83.33	51.8	22.5
		Culvularia Leaf Spot	83.33	76.25	15.75
		Brown Spot	83.33	80	23.4
		Maize Streak Virus	16.67	15	15
	Guto Gida	Turcicum Leaf Blight	100	91	45.8
		Eyespot	100	26.25	11.5
		Phaeosphaerialeaf Spot	60	59.33	8.67
		Gray Leaf Spot	80	80.75	12.25
		Culvularia Leafspot	100	100	15.4
		Brown Spot	40	62	13.5
		Maize Streak Virus	60	30.67	14.33
		Maize Head Smut	40	20	15
	Sibu Sire	Turcicum Leaf Blight	100	81.25	55.5
		Eyespot	100	49	19.75
		Phaeosphaeria Leaf Spot	100	72.75	38
		Gray Leaf Spot	75	76.67	17.33
		Culvularia Leaf Spot	75	90	24
		Brown Spot	0	0	0
	Jimma Arjo	Turcicum Leaf Blight	100	100	41.5

		Phaeosphaeria Leaf Spot	100	100	27
		Eyespot	0	0	0
		Gray Leaf Spot	100	100	29
		Culvularia Leaf Spot	80	85	25
		Brown Spot	100	66	30
Buno Bedelle	Chawaka	Turcicum Leaf Blight	100	82.5	41
		Culvularia Leaf Spot	83.33	94	22.6
		Gray Leaf Spot	80	58.67	37.4
		Brown Spot	50	40.33	24.75
		Phaeosphaeria Leaf Spot	66.67	42.75	18.5
		Eyespot	80	41.6	10.2
		Maize Streak Virus	100	18.33	10.83

Sorghum diseases

Sorghum disease prevalence

The survey results indicated that Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum* Pass), Zonate Spot (*Gloeocercospora sorghi*) and Loos Smut (*Sporisorium sorghi*) were the major diseases of high prevalence in two districts of the study area with high incidence and severity level (Table 3). The prevalence of sorghum Anthracnose (*Colletotrichum sublineolum*) and Leaf Blight *(Helminthosporium turcicum)* were 100% in both surveyed districts (Table 3). Sorghum Zonate spot disease prevalence was assessed in Chawaka and Diga where prevalence of 80% and 76%, respectively were recorded. Sorghum loose smut prevalence was recorded to be 66.67% in Diga District and 20% in Chawaka District (Table 3).

Sorghum disease incidence

Sorghum Anthracnose *(Colletotrichum sublineolum)* disease incidence was found to be100% in all surveyed fields. The surveyed areas were categorized under high Anthracnose disease incidence (Table 3). Disease incidence of Zonate Leaf Spot was recorded to be 70% and 42%inDigaand Chewaka Districts, respectively. Incidence of Sorghum Leaf Blight was 66% and 90.67% in Chawaka and Diga districts, respectively (Table 3). Also sorghum Loose smut incidence was recorded in both Districts; 34.5% in Diga and10 % in Chawaka (Table 3).

Sorghum Disease Severity

In Diga district disease severity was 48%, 19.94%, 26% and 28% for Anthracnose, Leaf Blight, Zonate Spot and Loos Smut, respectively where as in Chawaka district, the severity level of the diseases was 54.5%, 34.5%, 26% and 18% in that order (Table 3).

Table 3: Percentage of Prevalence, Incidence and Severity of Sorghum diseases in surveyed fields

Zones	Districts	Types of disease	Disease Prevalence %	Disease Incidence %	Disease Severity %
East Wollega	Diga	Anthracnose	100	100	48
		Leaf blight	100	90.67	19.94
		Zonate spot	76	70	26
		Loos smut	66.67	34.5	28
Buno Bedelle	Chawaka	Anthracnose	100	100	54.5
		Leaf blight	100	66	34.5
		Zonate spot	80	42	26
		Loos smut	20	10	18

Wheat, barley and rice diseases

Several wheat diseases such as yellow rust (*Puccina stiriiformis*), stem rust (*Puccina graminis*), Septoria Leaf Blotches (*Septoria tritici spps),* Fusarium Head Blight *(Fusarium graminearumspps)* and loose smut *(Ustilago tritici)* were recorded in all wheat growing areas covered by this survey (Table 4). According to the results of this survey, however, most of the wheat diseases except Fusarium Head Blight and Septoria Leaf Blotch appeared *to be of* minor importance from disease severity point of view. Septoria Leaf Blotches of wheat occurred in Guduru, Chalia and Horro districts with mean severity level of 53%, 49% and 34%, respectively. Similarly, Fusarium Head Blight had mean severity level in the range of 19.8%-26.7% and occurred in all the three districts surveyed for wheat (Table 4).

Diseases recorded for barley in Chalia, Guduru and Horo districts include yellow rust (*Puccina stiriiformis*), stem rust (*Puccina graminis*) and Net Blotch (*Pyrenophora teres* or *Helminthosporium teres*). Net blotch appeared to be the most important of all the diseases recorded on barley with severity level ranging from 26.2% to 34%; yellow and stem rusts appeared to be of minor importance. Rice diseases were assessed in Chawaka district andthree diseases namely Brown spot (*Cochlidolus miyabeanus*), Blast (*Magnaporthe oryzae*) and Bacterial Blight (*Xanthomonas oryzae pv. oryzae*) were recorded with mean severity level of 26.89%, 34.6% and 27.6%, respectively.

Table 4: percentage of prevalence, incidence and severity index of Wheat, Barley and Rice crops disease

Zones	Districts	Types of crops assessed	Types Of Disease	No. of field assessed	Prevalence %	Incidence rage	Incidence mean %	severity range	Severity mean %
West Shoa	Chalia	Wheat	Fusarium Head Blight	7	92	0-54	37.6	0-34	26.7
			Septoral Blotch	7	100	45-67	56	34-54	49
			Yellow Rust	7	50	0-39	34	0-26MS	11
			Stem Rust	7	46	0-41	31	0-27MS	19
			Loos Smut	7	25	0-19	13	0-16	11
			Net Blotch	6	100	60-100	84.66	32-49	42.6
Horro Guduru Wollega	Guduru	Wheat	Fusarium Head Blight	8	63	0-39	30	0-37	22.5
			Septoral Blotch	8	100	65-89	76	46-58	53
			Yellow Rust	8	33.34	0-30	21	0-18MR	12
			Stem Rust	8	33.34	0-27	22	0-17MR	12
	Horro	Wheat	Fusarium Head Blight	8	66.67	0-51	43	0-30	19.8
			Septoral Blotch	8	100	59-99	88	24-44	34
			Yellow Rust	8	42	0-49	33	0-29MS	24
			Stem Rust	8	61	0-45	38	0-16MS	9
West Shoa	Chalia	Barley	Stem Rust	6	57	0-44	38	0-28MS	21
			Yellow Rust	6	43	0-39	35	0-19MS	13
Horro Guduru Wollega	Guduru	Barley	Net Blotch	7	66.67	0-86	54	0-38	30
			Stem Rust	7	55	0-39	32	0-25MR	13
			Yellow Rust	7	33.34	0-17	14	0-16MR	9
	Horro	Barley	Net Blotch	6	100	45-78	62	18-34	26.2
			Stem Rust	6	80	0-37	29	0-19MR	14
			Yellow Rust	6	20	0-27	20	0-18MR	12
Bono Bedelle	Chawaka	Rice	Brown Spot	10	100		92.67		26.89
			Blast	10	100		61.67		34.6
			Bacterial Blight	10	33.33		43.33		27.67

Conclusion and Recommendation

Generally, the results of survey conducted in four Zones and 10 districts of the Western part of Oromia in 2019 and 2020 has enabled to document various diseases that occur on the five major cereal crops: maize, wheat, sorghum, barley and rice. Some of the diseases are quite economically very important from view point of key parameters such as severity while others, though have wide prevalence and incidence, are less important from disease severity point of view. Research should focus on the major diseases showing high level of severity to avail various alternatives of management, towards developing Integrated Pest Management.

Major maize diseases that prevailed in the study area include Turcicum Leaf Blight (*E. turcicum*), Eyespot (*Kabatiella zeae*), Phaeosphaeria Leaf Spot (*Phaeosphaeria maydis*), Gray Leaf Spot (*Cercospora zeae-maydis*), Culvularia Leaf Spot (*Curvularia pallescens*), Brown Sport (*Physoderma maydis*), Maize Streak Virus and Maize Common Smut (*Ustilago maydis*). Major diseases of sorghum were Anthracnose (*Colletotrichum sublineolum*), Leaf Blight (*Helminthosporium turcicum* Pass), Zonate Spot (*Gloeocercospora sorghi*) and Loose Smut (*Sporisorium sorghi*) which could be considered as quite important because of high severity level. Although many common diseases were recorded in the surveyed districts, the results of severity level show that only two of the diseases – Spetoria Leaf Blotch and Fusarium Head Blight appeared to be economically important. Similarly, Net Blotch appeared to be the most important disease for barley. Three disease of rice i.e Brown spot, blast and bacterial blight were recorded for rice in Chawaka district.

In addition to the survey results, yield loss assessments may be required for some crop-diseases combinations in order to determine whether they are economically important or not. Loss assessments could be of quantity or quality based on the purpose of production of the particular crop. Moreover, areas that have not be covered by the current survey, but yet offer high potential for the production of these crops, need to be surveyed to get broader understanding of specific crop-disease combinations and their economic importance.

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