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Current Status of Major Coffee (*Coffea arabica* L.) Diseases in BunoBedele and Ilu Abba Bor Zone, South Western Oromia, Ethiopia

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Abstract

In Ethiopia, coffee is the most important crop in the economy of the country which has used as a source of foreign income and also millions of the people relying on coffee production for their livelihood. However, its production and productivity has been decreasing due to major biotic factors, such as diseases, insect pests and weeds. Especially coffee diseases have been very important to limit the yield and quality of coffee in the study areas. Therefore, to overcome these problems, there is need to assess major diseases which are highly result in coffee yield loose at growing areas. This assessment was conducted at BunoBedele and Ilu Aba Bora,a zone which includes six districts kindly Gachi, Chora, Didesa, Ale, Halu and Yayo. The result of this study revealed that three coffee diseases were occurred at the study areas. From these diseases CBD was more severe at all districts by 61.6% of Incidence followed by CLR (59.1%) incidences. CWD was also observed at all districts by 32.9% mean intensity. Generally, from the results the production and productivity of coffee in the study area was threatened by these major diseases. Therefore, these major diseases should be get considerations in surveyed areas to practiced and design an appropriate management options for its management.

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Keywords

Coffea arabica L., CBD, CLR, CWD, Incidence, Severity.

Introduction

Coffee is an important export crop and a major foreign exchange earner for Ethiopia. According to Petit *et al.,* (2007) coffee is a backbone of Ethiopian fiscal underlying 41% of foreign exchange, Supporting more than 1million farming household, fascinating 25% employment opportunity and 10% of government income.

It is the most important and valuable commodity in Ethiopia and in the world supporting the economic growth and providing job opportunity to millions of people. Ethiopia is the leading producer in Africa, and the 5th in the world, following Brazil, Vietnam, Colombia and Indonesia and produces premium quality coffee (USDA, 2021). Ethiopia the 10thcoffee exporter with 4.79 percent share of the world total (Bellachew, 2015). If we consider Arabica coffee alone, Ethiopia is the 3rd largest producer after Brazil and Colombia (USDA, 2021).

In Ethiopia, coffee has being contributes to the Lion's share in its national economy being the leading source of foreign exchange earnings. Besides, the livelihood of a quarter of the Ethiopian population depends directly or

indirectly on the different processes of production and marketing along the coffee value chain (Girma *et al.,* 2008).

In Ethiopia, the overall land area devoted to coffee production due to new plantings is increasing and estimated to be 662,000 hectares, of which 496,000 hectares are estimated to be productive. The average annual production is amounting to about 350,000 t and productivity of about 0.71 t/ha (Alemayehu *et al.,* 2008). Here, coffee is produced under four broad production systems, i.e. forest coffee (8-10%), semiforest coffee (30-35%), cottage or garden coffee (50-57%) and modern coffee plantations (5%).

However, its production and productivity is mainly constrained with many factors, among biotic factors like diseases, insect pests and weeds are the major one. Despite the largest share in production and economic contribution, *C. arabica* is threatened by several coffee diseases which remain among the major constraints to reduced production and productivity in many parts of Ethiopia. About fourteen fungal diseases and one bacterial disease have been reported to attack the crop (Eshetu*et al.,* 2000). Amongst coffee berry disease (CBD) caused by *Colletotrichum kahawae*, coffee wilt disease (CWD) caused by *Gibberella xylarioides* and coffee leaf rust (CLR) caused by *Hemileia vastatrix* are the three major economically important biotic coffee production constraints in the country (Eshetu *et al.,* 2000). Although the rest were found minor importance under current situation, a few diseases like coffee thread blight and bacterial blight of coffee have been identified potential threat for Arabica coffee (Belachew, 2015). Since coffee is perennial crop that remains on the field through the year for many years and allows some pests to maintain an endless succession of generations (Arega, 2009).

South western part of Oromia including BunoBedele and Ilu Aba Bora Zones are potential area in coffee production. In these areas like another Ethiopian coffee growing areas coffee production has been threatened by different factors, mainly biotic factors (diseases, insect pests and weeds). Yet there has been lack of information related to geographical occurrence, distribution and status of coffee diseases in these areas. So, Assessment of coffee plant diseases is important to design proper management strategies. Thus, assessment is an essential work in terms of obtaining baseline information about major diseases of coffee in one study area for designing sound management options. The activity was initiated with the objective to assess prevalence, incidence and severity of coffee diseases at BunoBedele and Ilu Aba Bora coffee growing areas.

Materials and Methods

Description of study areas

The survey of major coffee diseases was undertaken in major coffee producing areas of BunoBedele zone, namely Chora, Gachi and Didesa and major producing areas of Ilu Aba Bora zones, namely Ale, Halu and Yayo districts. These districts were purposively selected for their coffee production and disease prevalence. Geographical information was recorded by using GPS at the point of farm assessed (Table 1& Figure 1).

Methods of coffee Disease Assessment

Each district was categorized into highland, midland and lowland agro ecologies. From each agro ecology 5 farmer's farms were sampled in interval of 3-5 km. Ninety farms were assessed for the diseases and other required data was collected. At each farm a questionnaire was administered and the owner was asked about the age tree, type of coffee cultivar/landraces and the diseases history. The farms also were diagnosed for agronomic practices applied, weed control methods, shade tree condition (shaded or un-shaded) and factors which contribute in occurrence and distribution of diseases. Major disease assessment methods like prevalence, incidence and severity were used during field assessment. Generally, the collected coffee disease data was measured and summarized according to the following formula.

Disease Incidence

The numbers of infected and healthy trees were counted. Then, Incidences of the diseases were calculated:

$$\text{Disease Incidence (\%)} = \frac{Total\ infected\ tree}{Total\ assessed\ tree} X100$$

Disease Severity

Each tree classified into three strata of branches (top, middle and bottom). From each stratum two branches were selected to record disease severity. Then, disease damaged and healthy berries/ other tissues were counted and calculated as follows:

$$\text{Disease severity (\%)} = \frac{Total\ infected\ berries/leaves}{Total\ counted\ berries/leaves} X100$$

Disease Prevalence

The infected farms were recorded. The prevalence was calculated

$$\text{Disease prevalence (\%)} = \frac{Total\ infected\ farm/field}{Total\ surveyed\ farm/field} X100$$

Data analysis

Collected data was entered into computer using Excel Spread Data Sheet and analyzed by using SPSS computer software.

Results and Discussion

The Prevalence of Coffee Disease at Buno Bedele and Ilu Aba Bora Zones

The result of this study was revealed that three major coffee diseases occurred at the study areas. The prevalence of CBD showed that highest prevalence (93.30%) recorded from Didesa district followed (86.70%) recorded from Ale, Chora, Gachi and Halu districts. The lowest prevalence (73.30%) CBD recorded from Yayo district. The highest CLR (100%) prevalence recorded at Yayo district and the lowest (73.30%) CLR prevalence was recorded at Didesa district.

The highest (73.30%) of CWD prevalence recorded from Yayo and Chora districts, the lowest (46.70%) CWD prevalence was recorded from Halu district. This result shows more farms of BunoBedele and Ilu Aba Bora zones occurred by CLR and CBD diseases followed by CWD disease (Figure 2).

The Incidence and Severity of Coffee Disease at Buno Bedele and Ilu Aba Bora Zones

The highest (61.6%) mean of CBD incidence was recorded at all districts followed by (59.1%) mean of CLR incidences at surveyed districts. CWD was also observed at all districts and recorded with mean intensity 32.9% (Table 2). The range of CBD was 22.5-89 followed by 31-82 range of CLR Incidences.

The highest (55.0%) severity of CBD was recorded from Gachi district followed by (54.4%) from Chora district. The lowest (44.7%) of CBD severity was recorded from Yayo district. The result of CLR severity was recorded at all districts, the highest (60%) was recorded from Yayo, whereas, the lowest (41.2) recorded from Ale district.

The status of Incidence and Severity of Coffee Diseases across Different Agro ecology

The highest (52.0%) CBD mean incidence was recorded at the highland of Gachi district and followed by Ale district (50.0%). The lowest (6.0%) CBD mean incidence was recorded at the lowland of Yayo district. The highest (50%) mean incidence of CLR was recorded at the lowland of Yayo district and followed by lowlands of Chora, Halu and Didesa districts by mean of 36%. The lowest (14.0%) was recorded from the midlands of Halu, Didesa and highland of Chora district (Table 3).

This result was similar with earlier study (Abdi, 2020) which revealed the incidence and severity of CBD was very high at higher altitudes. This shows that CBD favors high rainfall, high altitude and humidity areas than lowland areas, where as CLR favors at lowland agro ecology. Similarly, Bayetta (2001) explained high CBD occurrence related with high humidity with high altitude around Gera.

This might be at higher elevations low night temperatures followed with low day temperatures was found which make the pathogen in passive for a longer period and slower epidemic while in lower elevation it hastens rust development since high temperature make suitable condition for pathogen. At lower altitudes, CLR may benefit from higher temperatures (Lamouroux *et al.,* 1995).

The highest (50%) CWD incidence recorded from lowland of Chora followed by 30% followed by midland of Yayo district. The lowest (16%) incidence was recorded from highland of Gachi district. This shows that with extended dry seasons predicted in future climatic scenarios that CWD could have a more severe impact (CABI, 2021).

The highest severity of CBD was recorded from the highland of Ale district by 38.6% then followed by highland of Gachi district with 33.8%, whereas, the lowest (5.2%) was recorded from lowland of Yayo district. The highest severity of CLR (47.6%) was also recorded at the lowland of Yayo district followed by

29.4% of lowland of Halu district, whereas the lowest (10.6%) was recorded from midland of Ale district (Figure 3). This result shows coffee grown in lower altitudes is more predisposed to the CLR and suffers more attacks (Ritschel, 2005).

The Effect of Shade Condition on the Status of Coffee Diseases in surveyed areas

The result showed that the lowest severity (12.4%) CLR was recorded from shaded coffee farms than un shaded farms, whereas the highest severity (22%) was recorded from un shaded farms (Figure 4). This shows in low shade level or unshaded condition efficient light penetration under such conditions make high temperature which in turn increases disease intensity of CLR diseases.

Additionally, there might be the presence of optimum microclimate conducive for pathogen occurrence and distribution (Ano. *et al.,* 2021). This result agrees with the previous reported of Mohamedsani and Hika, (2017) which revealed that the incidence of CLR was lower under shade condition but higher under unshaded farms.

In other wise this study results showed that the highest mean incidence (36%) and severity (27%) of CBD was recorded from coffee farms covered with shade tree. This might be due to the most favorable shade for the fungus was that provided by fruit trees or forest species and an absence of pruning also acted in favor of the fungus.

Due to that the wetter period, the more intense were the epidemics. CBD development depends on climatic factors such as rainfall, temperature, and relative humidity (Guyot *et al.,* 2001). Rainfall is the main agent of *Colletotrichum* spp. conidium dispersal (MouenBedimo*et al.,* 2006). Most of Coffee growing areas in BunoBedele and Ilu Aba Bora are under forest and more shaded which not regulated as Coffee needed.

Therefore, CBD was critical disease at study area. This result agrees with the work of Avelino *et al.,* (2007) who reported that reducing losses caused by the disease through the use of shade plants is an original prospect for reducing CBD impact, because the incidence of fungal diseases is often greater under shade.

This result also, dis agrees with (MouenBedimo *et al.,* 2008) who reported shade could limit rain intensity and subsequently, reduced splash dispersal of *Colletotrichum kahawae*. CWD also recorded from the study areas highest incidence (20%) from un shaded coffee areas and lowest incidence (14%) was from shaded condition.

This result shows Coffee wilt disease was found in all assessed forest coffee areas suffering considerably in coffee tree losses. This result agrees with Damelash, (2018) who reported the mean incidence (16.9%) was recorded previously from Yayo forest.

The Effect of Agronomic Practices on the Status of Coffee Diseases in surveyed areas

The result revealed that hoeing practice reduced the incidence of CBD (14%) than slashing and intercropping practice, whereas incidence of CLR (12%) reduced by slashing practice (Table 6). According to the current study different agronomic practices were had effects on severity and incidence of the diseases.

The incidence and severity of disease under intercropping practice was very high. This might be due to crops are serve as source of harbor for disease. The lowest incidence diseases were 2.3%, 1.6% and 1.4% recorded by CBD, CLR, and CWD, respectively under pruned coffee plants. This result agrees with MouenBedimo *et al.,* (2007) and Joseph (2012) observed that high level management including:- pruning, mulching, appropriate fertilizer application and good weed control contribute to masking the adverse effect of CLR and CBD epidemic on Arabica and Robusta coffee.

These good management practices increase plant vigor, making them more tolerant to disease attack (Joseph, 2012). This indicates that in areas of good management practices the intensity of rust was low as compare to poor management practices.

The result in the Figure 4 showed that, different agronomic practices had different effects on the types of coffee diseases. Slashing decreased Incidence of CLR (12%) followed CBD (16%) and CWD (24%). Pruning method also decreased the Incidence of CWD (1.4%) followed CLR (1.6%) and CBD (2.3%).

From this results Pruning practice was very important to decrease the Incidence of Coffee diseases. However, Intercropping was no significant between different diseases of coffee at the study areas. Cultural agronomic practices (pruning and stumping) that bring about wounding in coffee trees should be done with efficiently disinfected tools to avoid coffee wilt disease (Asmamaw, 2019).

Table.1 Weather conditions of assessed districts of BunoBedele and Ilu Aba Bora zones during 2021

Districts	Altitude (masl)	Latitude N	Longitude E	Rainfall (mm)	Min. temp (°C)	Max. temp (°C)
Ale	1648-2377	8°02'0.00"	35°39'59.99"	1982	14	19
Chora	1470-2516	8°19'60.00"	36°14'60.00"	1350	9	31
Didesa	1428-2512	8°04'60.00"	36°39'59.99"	1800	13	28
Gachi	1363-2553	8°19'60.00"	36°39'59.99"	1100	13	18
Halu	1370-1917	8°08'51.26"	35°20'27.74"	1450	18	24
Yayo	1304-2587	8°20'35.09''	35°48'58.83''	2300	7	32

Table.2 Status Incidence and Severity of coffee diseases at Buno Bedele and Ilu Aba Bora zones

District	Disease Incidence			Severity (%)	
	CBD	CLR	CWD	CBD	CLR
Chora	68.5	62.5	34.3	54.4	51.1
Didesa	66.0	53.3	29.3	52.3	44.4
Gachi	69.4	52.6	34.3	55.0	43.4
Ale	62.0	56.0	36.7	46.9	41.2
Halu	52.7	62.3	30.7	45.1	52.7
Yayo	50.9	68.3	32.3	44.7	60.0
Mean	61.6	59.1	32.9	49.7	48.8
Range	22.5-89	31-82	13-47.5	18-74	26-77

Where: CBD: Coffee Berry Disease, CLR: Coffee Leaf Rust, and CWD: Coffee Wilt Disease

Table.3 Status of major coffee disease incidence under different coffee Agro-ecology during 2021

Districts	Incidence (%) of Disease per agro ecology								
	CBD			CLR			CWD		
	Highland	Midland	Lowland	Highland	Midland	Lowland	Highland	Midland	Lowland
Gachi	52.0	36.0	20.0	30.0	24.0	30.0	16.0	27.5	30.0
Chora	42.0	26.0	22.0	14.0	20.0	36.0	28.0	28.0	50.0
Didesa	44.0	42.0	24.0	20.0	14.0	36.0	22.0	38.0	24.0
Ale	50.0	32.0	24.0	20.0	14.0	30.0	24.0	20.0	28.0
Halu	40.0	18.0	12.0	18.0	24.0	36.0	24.0	18.0	28.0
Yayo	18.0	14.0	6.0	24.0	30.0	50.0	24.0	30.0	24.0
Mean	41.0	28.0	18.0	21.0	21.0	36.3	23.0	26.9	30.6
S.d.	12.1	10.7	7.3	5.4	6.2	7.3	3.9	7.2	9.7

Where: CBD: Coffee Berry Disease, CLR: Coffee Leaf Rust, and CWD: Coffee Wilt Disease

Table.4 Status of Disease under coffee agronomic practice

Agronomic Practice	Incidence			Severity (%)	
	CBD	CLR	CWD	CBD	CLR
Slashing	16.0	12.0	24.0	20.0	14.6
Hoeing	14.0	16.0	14.0	15.4	17.8
Pruning	2.3	1.6	1.4	0.8	0.4
Intercropping	20.0	22.0	22.0	27.0	27.2
Mean	16.6	16.6	20.0	20.8	19.8

Where: CBD: Coffee Berry Disease, CLR: Coffee Leaf Rust, and CWD: Coffee Wilt Disease

Figure.1 Map of the study area

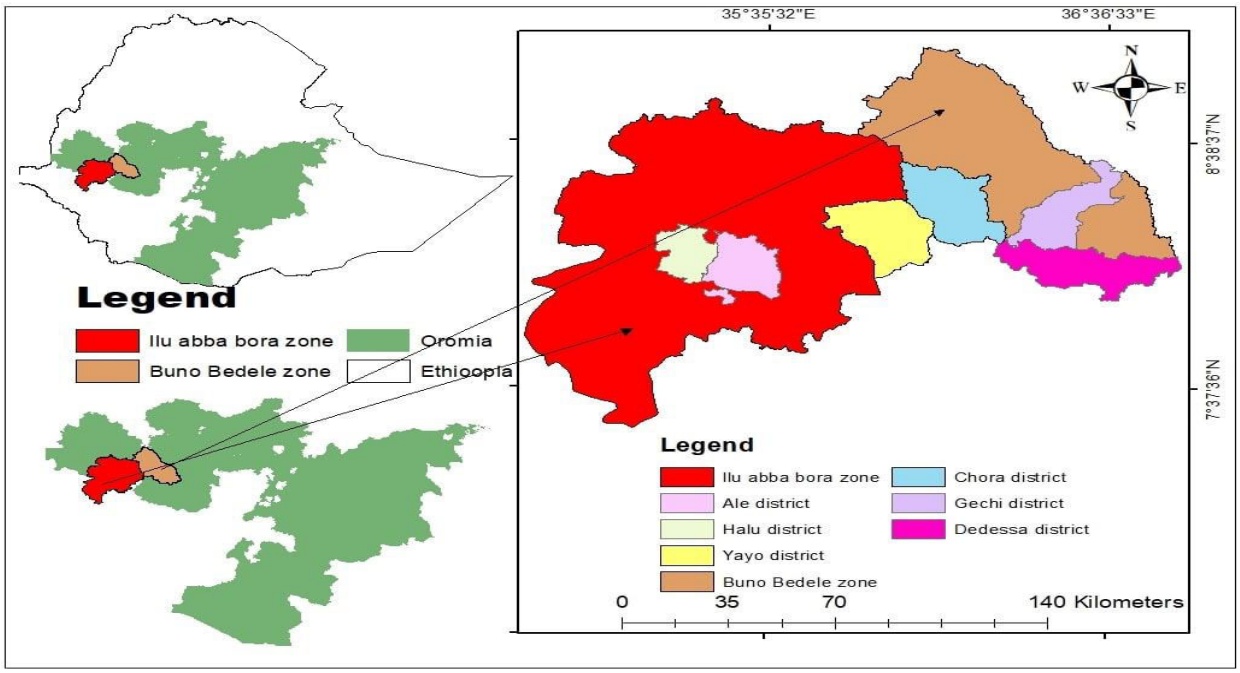


Figure.2 The prevalence status of coffee diseases at the study areas

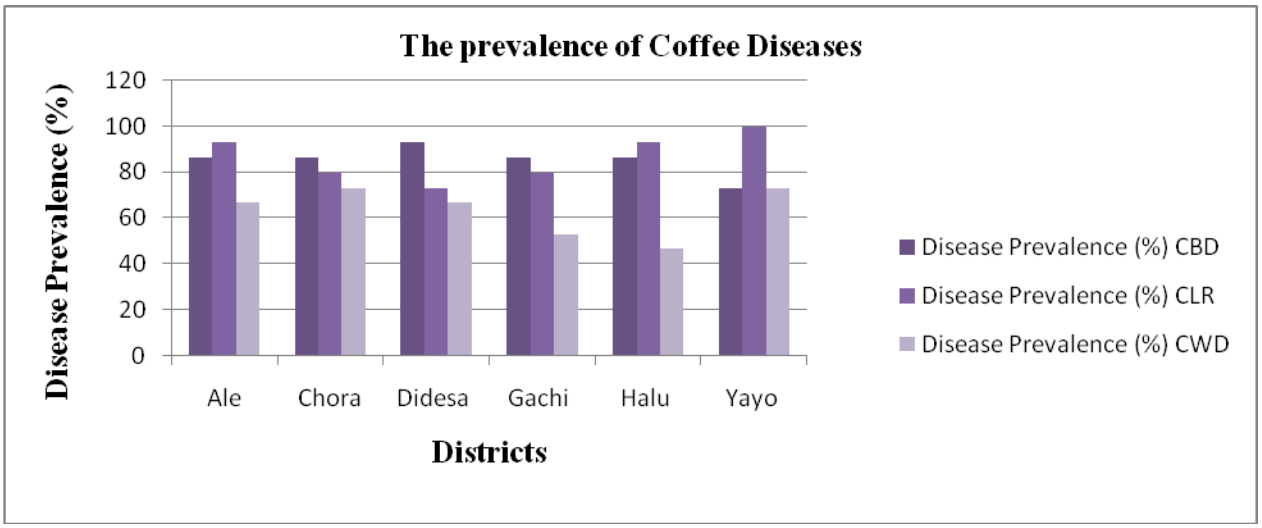


Figure.3 Status of Coffee Disease Severity under different Agro ecology

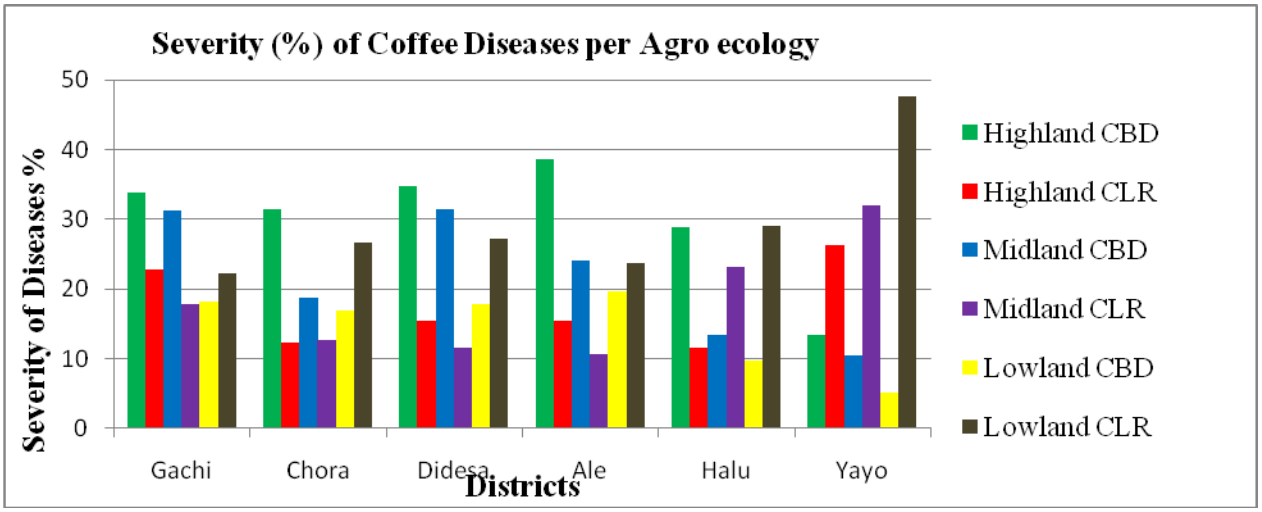
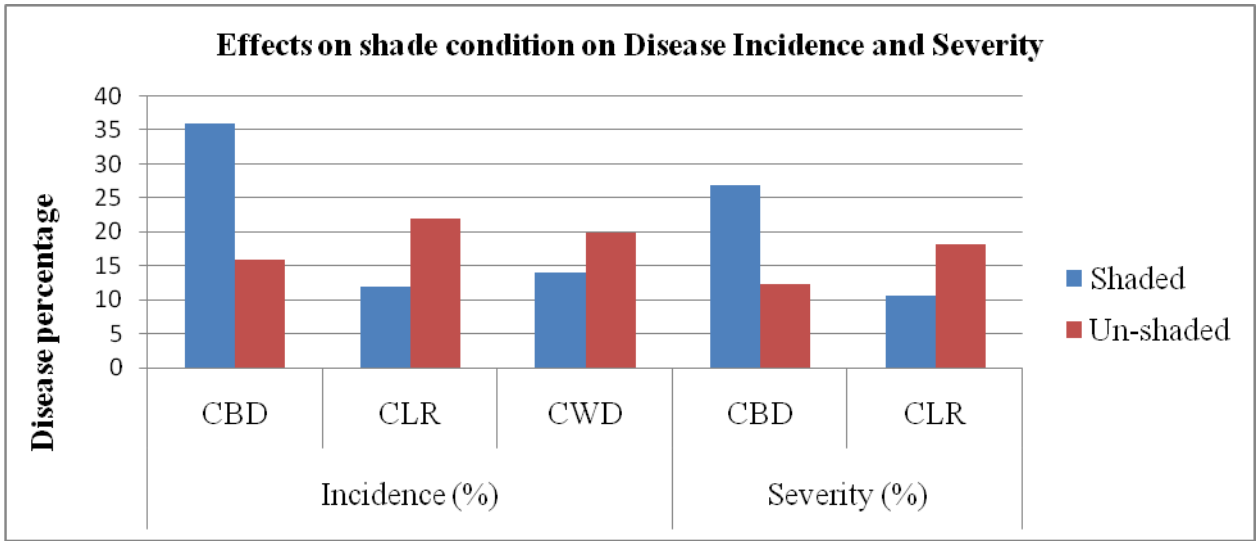


Figure.4 Effects of Shaded and un shaded condition on coffee disease Incidence and Severity



Conclusion and Recommendation

Major Coffee diseases occurred across all study areas.CBD, CLR and CWD were very important disease in all selected districts of both zones.

The status of all coffee diseases were varied based on the management practices, agro ecologies and shade conditions in all study areas. Coffee leaf rust and Coffee berry disease were highly increased in the study areas. Generally, high rainfall, high humidity or wetness, and relatively low temperatures that persist for long periods favor CBD development and the disease is invariably severe at higher altitudes where these conditions generally prevail. CWD is the leading disease of coffee, after CBD and CLR in Ethiopia and the most distractive coffee production threat without any solution till now. The soil-borne nature of the pathogen and perennial character of coffee have made management of the disease difficult through the conventional control approach of 'uproot and burn infected trees at the spot.

Additional, practicing proper coffee agronomic recommendation, consulting professionals and implementation were the knowledge gaps identified among the surveyed farmers in the study area. Further studies should be conducted on the seasonal variation and abundance of major disease assessment on the newly emerging and potentially important disease and the ecological influence on the distribution of disease, the

economic threshold level and management practices. As well as the effective integrated disease management strategies should be developed for the study areas.

Generally, adequate training for farmers, extension workers and district's experts on how to manage major disease ought to be given.

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