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RESEARCH ARTICLE

Assessment of the current status of coffee diseases at Gedeo and Sidama zone, Ethiopia

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Abstract

Coffee arabica is the key cash crop and top mainstay of the Ethiopian economy and requires sustainable production methods. Coffee berry disease (CBD) is a fungal disease caused by *Colletotrichum kahawae* and is one of the major diseases of *Coffea arabica*. It causes berry rots, yield loss, and even death of the tree in severe cases. Coffee Wilt Disease (CWD), also known as 'fusarium wilt' or 'tracheomycosis', affects *Coffea arabica* as well as wild coffee species and caused by the fungus *Fusarium xylarioides* and finally resulting wilting of coffee tree. The study covered sites that were truly representative of all the coffee growing of Gedeo and Sidama zone, where the prevalence and distribution of diseases was determined. This study was aimed to developing awareness and disseminating information to concerning bodies and farmer and finaly to bring out the radical change on coffee yield production. According to the survey results, mostly coffee berry disease was widespread than coffee wilt disease and also the current coffee disease. So, it was to summary up that coffee production Gedeo and Sidama zones was on threating unless otherwise taking appropriate measurement which solve this problem, otherwise, the country will be lost foreign currency as a result, the life standard of farmer will be collapse and leading to lost foreign income.

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Introduction

The word "coffee" comes from the name of a region of Ethiopia where coffee was first discovered–'Kaffa'. The name 'Kaffa' is inherited from the hieroglyphic nouns 'KA' and 'AfA'. 'KA' is the name of God, 'AFA'is the name of earth and all plants that grow on earth. So the meaning of Koffee (Coffee) from it is birth-place bells on as the land or plant of God. Botanically, coffee is belonging to the family Rubiaceaein the genus Coffea. Although the genus Coffea includes four major subsections (Chevalier, 1947), 66% of the world production mostly comes from *Coffea arabica* L. and 34% from *Coffea canophora* Pierre ex Froehner (robusta type), respectively.

Ethiopia is the home and cradle of biodiversity of *Arabica coffee* seeds. More genetically diverse strains of *C. arabica* exist in Ethiopia than anywhere else in the world, which has lead botanists and scientists to agree that Ethiopia is the centre for origin, diversification, and dissemination of the coffee plant (Fernie, 1966; Bayetta, 2001). Ethiopia is well known as the country of origin of "Buna" (coffee in Amharic) but it is also one of the poorest countries in the sub Saharan region, with aper capita income of about US$ 100 (UN, 2004), which is one of the lowest in Africa. The estimated coffee production area (2% of total cultivated land) in Ethiopia is in the range 320,000-700,000 ha (FAO, 1987); although there are a potential 6 million ha of cultivable land suitable for coffee production (Mekuria et al., 2004).

In general, all Ethiopian coffee cultivation systems appear to be under the same system of cultivation techniques. However, the major conventional production systems include: i) forest coffee (10%); ii) semi-forest coffee (35%); iii) garden coffee (50%); and iV), plantation coffee (5%) (Aga et al., 2003; Mekuria et al., 2004; Petit, 2007). Agriculture is the main stay of Ethiopian economy, and contributes to more than 50% of GDP, 80% of exports and 85% of employment. Coffee is the major agricultural export crop, providing currently 35% of Ethiopia's foreign

exchange earnings, down from 65% a decade ago because of the slump in coffee prices since the mid-1990's. In a country where about 44% of the population is under poverty (Woods, 2003), coffee cultivation plays a vital role both in the cultural and socio economic life of the nation. About 25% (15 million) of the Ethiopian population depend, directly or indirectly, on coffee production, processing and marketing.

Organic coffee production is based on the use of renewable resources and clearly aims to sustain management of natural resources (soil, biodiversity, water, nutrients, energy) (IFOAM, 1998; Demeter, 1986). For the organic coffee sector, quality control through inspection and certification is compulsory (Kotschi and Adelhelm, 1984). In Ethiopia, onset of certified organic farming arised from a market deficit of the conventional coffee farming, but there is little information documented about such important segment of coffee production and the country's economy. A coffee quality can be defined in terms of its organoleptic cup quality (cup of excellence), physical appearances, and inherent chemical constituents (sugars, caffeine, volatile and non volatile phenolic contents) of a green bean produced. Moreover, today's definition of a coffee quality is comprised of some more additional characters, which include the description of the way how the crop is grown and how its quality is settled up matching to consumer's preference by a third party. According to the Specialit y Coffee Association of America's as noted by David (1997) coffee quality refers to "... total quality which encompasses quality of life, quality of cup and quality of the environment...". Similarly, the Speciality Coffee Association of Europe (SCAE) defined speciality coffee as a way of market presentation to charm consumers, which entails certain principal concepts derived from the origin of cultivation, genotypes, processing levels, and cropping systems (organic, shade, mountain).

Ethiopian farmers normally produce different types of single origin speciality of *Arabica coffee*. For conventional producers, there are clearly identified nine spectra of single-origin-speciality coffee (Jimma, Nekemte, Illubabor, Limu, Tepi, Bebeka, Yirga Chefe, Sidamo, and Harar) which are so far well diffused into the trade circuits of coffee world. Among them the sundried coffee beans from 'Harar' the so called "Mocca" and washed beans from 'Yirga Chefe' are considered as the finest and best of all coffees. The certified organic farmers observed to produce mainly the three speciality types: 'Limu', 'Sidamo', and 'Yirga Chefe'. Within the domain of 'Yirga Chefe' speciality, fore example, the finest coffee is said to be harvested in the altitude ranges between1500 to 2000 m above sea level, whereby the majority of farmers owned garden coffee with interacted diversity of mixed cropping systems (false banana, sugar cane, sweet potato, Irish potato, maize, sorghum, cabbages) combined with apiculture (Mekuria et al., 2004). Most of the coffee is consumed in the northern partof the world, while 90 % of the production takes place in the South (Coffee and Tea Authority, 1999). It is in fact one of the most important primary export commodities of developing countries and the fifth most internationally traded good. Coffee is big business globally, but local Ethiopian small scale farmers receive only a fraction of the retail price and continue to engage in subsistence farming (Bäckman, 2009).

Coffee berry disease (CBD), which affects *Coffea arabica*, is caused by the fungus *Colletotrichum kahawae*. It is endemic to Africa and was first recorded in western Kenya in 1922. Since then the disease has spread to most *C. arabica* growing countries on the continent and is currently known to occur in Angola, Burundi, Cameroon, Central African Republic, Democratic Republic of Congo (DRC), Congo, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe. CBD can cause considerable yield losses of up to 75% when not adequately controlled. Even though application of fungicides to control the disease can result in yields being doubled, losses of up to 30% can still occur when attack is severe. Yield losses occur as a result of shedding and/or destruction of infected berries, which become mummified (dry, wrinkled and decayed, with a hard skin). The pathogen can infect berries at the pinhead, expanding, mature green and ripe stages of development, as well as flowers. However, most losses are due to infection of the green expanding berries, between four and six weeks after flowering, when they are most susceptible, and also under wet conditions. (Rutherford and Phiri, 2006).

Coffee Wilt Disease (CWD), also known as 'fusarium wilt' or 'tracheomycosis', affects *Coffea arabica* and *Coffea canephora* as well as wild coffee species. It is a vascular wilt disease caused by the fungus *Fusarium xylarioides*. This is the asexual stage (anamorph) of the fungus, *Gibberella xylarioides* being the sexual stage (teleomorph). CWD has been known to occur in Africa for more than 70 years, having first been reported in Central Africa Republic (CAR) in 1928 (Rutherford and Phiri, 2006). The disease had first been recorded in Ethioipia (Kaffa Province) in 1957, and the causal organism was identified as *Fusarium oxysporum* f sp. Coffeae (Stewart, 1957).

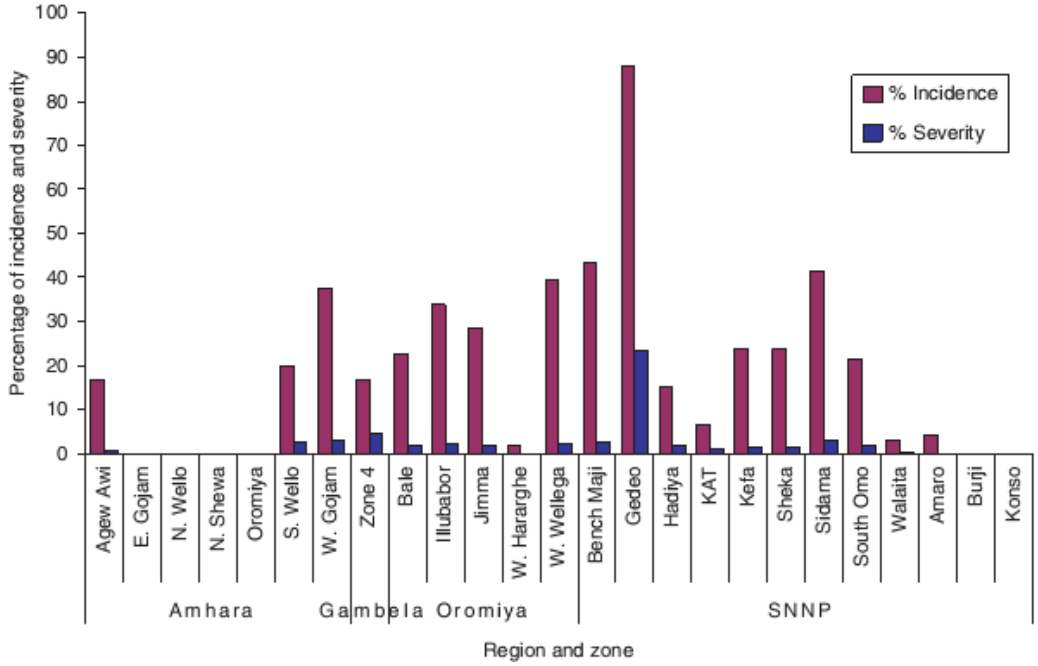
Bacterial blight of coffee (BBC) disease has been described in Brazil, Kenya, Uganda, and China where it is becoming of some concern due to its higher incidence and severity (Silva et al., 2006). The symptoms include dark, water soaked necrotic lesions on leaves, tips and nodes of vegetative and cropping branches culminating in a die back (Mugiira et al., 2011). It can be a serious problem in high altitudes, where plants are injured from heavy winds (Jansen, 2005) and have a protracted bimodal pattern of rainfall and often experience storms accompanied by hail (Kairu et al., 1985). Bacterial Blight of Coffee caused by *Pseudomonas syringae pv garcae* has become of manior concern in Kenya.

Coffee production is fundamental for over 50 developing countries, for which it is the main foreign currency earner (Gichimu and Omondi, 2010). Coffee is the most important commercial crop in the national economy of Ethiopia, contributing 60% of its foreign exchange earnings and nearly 25% of Ethiopian population depends, directly or indirectly on coffee for a livelihood by involving in the production, processing, and marketing of coffee as the major contribution to the development of the rural and the national economy (CTA, 1999; Dubale and Teketay, 2000). Coffee production systems in Ethiopia are grouped into four broad categories namely, forest coffee, semi-forest coffee, garden coffee and coffee plantations (MCTD, 1992). They account 10, 34, 35, and 21% of the total production, respectively. The most important cultivation areas are southwestern and southern Ethiopia.

For centuries Ethiopian coffee selections proved to be resistant or tolerant against many diseases and pests. Grown under indigenous shade trees coffee selections adopted to stand drought conditions and developed a certain tolerance. The few occurring pathogenic organisms and parasites facilitated best hosts for antagonists, hyperparasites, and natural enemies. However, Coffee production is constrained by a number of major diseases, including Coffee Leaf Rust (CLR) caused by *Hemileia vastatrix*, Coffee Berry disease (CBD) caused by *Colletotrichum kahawae* and Bacterial Blight of Coffee (BBC) caused by *Pseudomonas syringae pv. garcae* (Mugiira et al., 2011). The production of coffee is today severely affected by fungal wilt diseases (Adugna et al., 2001; Geiser et al., 2005; Serani et al., 2007; Silva et al., 2006). The disease is responsible for a reduction in the production of coffee beans and is also accompanied by severe damage and death of millions of coffee bushes (Adugna et al., 2001). Currently, attempts to control coffee wilt disease are fundamentally based on the breeding of resistant plants, plant and environmental management, and synthetic fungicides (Strange, 1993). The high cost of pesticides, the emergence of fungicide-resistant pathogen biotypes and other social and health related impacts of conventional agriculture on the environment have however recently led to an increased interest in agricultural sustainability, and biodiversity conservation (Van der Vossen, 2005). Thus, there is a need for new solutions of plant disease problems that provide effective control while minimizing cost and negative consequences for human health and the environment (Cook et al., 1996).

CWD is prevalent in the three major quality coffee producing districts of the southern region such as Wonago, Kochore, and Yirgacheffe of Sidama and Gedeo zones, with the highest incidence in Yirgacheffe. The severity of wilting seen in Yirgacheffe varied between 27 and 44% (Girma, 2004). Disease incidence varied widely across coffee growing areas of the Southern Nations and Nationalists and Peoples state (SNNP) region, with mean incidence (35%) and severity (5%) higher than in other regions. It was especially high in Sidama and Gedeo zones, with an incidence rate above 90% and severity of 25% (Phiri and Baker, 2009). There was, however, considerable variation, especially within the Gedeo Zone, home to Yirgacheffe, one of the world's most famous coffee origins, registering a CWD incidence level of 90% with a severity of 24% (Phiri and Baker, 2009) as indicated in fig 1.

Figure 1. Range of incidence and severity of infection in Ethiopian coffee regions (Phiri and Baker, 2009).



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MATERIALS AND METHODS

Study Area

Gedeo zone has a total area of 1347 square kilometer and it lies at an altitude ranging from 1350 to 3000 meter above sea level. The mean annual temperature of the zone ranges between 12.6-22.5°C and the mean annual rainfall ranges between 1001-1800 mm. The zone is consisting, these woredas, Wonago, Yirgachefe, and Kocher (http://www.southinvest.gov.et/potentialGedeo.htm).

Sidama Zone has an area of 7,672 square kilometers. The semiarid lowland (Amharic: *qola*) of the Rift Valley comprises 30% of Sidama (1200-1500 meters above sea level; 400-800 mm average annual rainfall; 20.0-24.9^{0}C average annual temperature range). The moist mid-altitude (Amharic: *woinadega*) comprises 54% of Sidama (1500-2300 meters above sea level, 1200-1600 mm average annual rainfall, 15.0-19.9^{0}C average annual temperature range). The cool moist highland (Amharic: *dega*) comprises 16% of Sidama (2300-3500 meters above sea level, 1600-2000 mm average annual rainfall, 15.0-19.5^{0}C average annual temperature range). The zone is consisting, these woredas, Yirgalem, and Aleta Cheko (http://www.africa.ufl.edu/asq/v6/V6i1a5.htm).

Survey methods

A stratified random sample of farmers and agricultural official were selected for interview and were given information about Coffee incidence disease at those woredas, Wonago, Yirgachefe, Kocher, Yirgalem, a nd Aleta Cheko. Field based evaluation studies can subsequently be conducted through observation of Sign on coffee crops at site of coffee farm area. Disease of coffee prevalence per farm was observed and recorded. At end of the survey, disease of the coffee was identified base on pathological characteristic.

Data analysis

The data was recorded and some observational survey of field results was indicated through figure.

RESULTS AND DISCUSSION

Coffee berry disease caused by *Colletotrichum kahawae* attacks coffee trees in the major coffee growing areas of Gedeo and Sidama Zone, Ethiopia. In some extent, Tracheomycosis/ coffee wilt disease caused by *Fusarium xylarioides* attacks coffee trees was also occur at coffee growing areas of Gedeo and Sidama Zone and Bacterial blight of coffee disease occurred at some site of these zones. According some coffee farmers, Organic coffee has impacts on our, rural development in Ethiopia by providing options to stabilise the market for organic growers. The local variety of coffee was more susceptible to any coffee disease than selecitve variety which was giving from reseach area. As a result, they were saying, organic coffee farming by itsef has one impact for unable to use other nourishment for improvement of coffee yield and controlling coffee disease. Moreover, coffee growers in Ethiopia have been exposed to price fluctuations and impacts of unpredictable and uncontrollable shocks. The effect of this price decline was manifested in increasing poverty among coffee growers, who previously were able to reap good benefits from their coffee sales. At household level the impact of depressed prices has been considerable, leading to distress sales of assets such as cattle, or to uprooting coffee plants and replacing them with annual food crops (Oxfam, 2002) or cash crops such as Chat Cost reductions, sustainability, and quality improvement are now the major priorities in coffee production systems and require organic growing of coffee.

According to some farmers and observation, the trend globally has been towards growing coffee without shade, so called 'sun coffee'. In direct sunlight, coffee yields can be significantly higher compared to shaded coffee. The problem with sun coffee that was requires much higher levels of external inputs. Sun coffee was often requires more

fertilisers, because of the higher levels of metabolism and production of the crop. Hence, problems arise when sun coffee farmers have to stop fertilising when prices crash. But, like legumes plant, some species of shade trees can fix nitrogen, enriching the soil. Therefore, shade trees also provide litter, which can act as natural mulch, reducing the need for fertilisers and herbicides. In the short term, increased costs of inputs needed for sun coffee can mean that the increased yields do not translate into increased profits for the farmer. In the long term, sun coffee is also more costly than shaded coffee because the productive life of the trees is much shorter: Sun coffee trees' productivity declines after 6-7 years, while shade coffee trees have a longer though lower productivity. In addition case, there is an occur of Bacterial blight of coffee disease caused by *Pseudomonas syringae pv garcae* especially at Aleta Cheko and Yirgalem woredas. Within the domain of 'Yirga Chefe' speciality, for example, the finest coffee is said to be harvested in the altitude ranges between1500 to 2000 m above sea level, whereby the majority of farmers owned garden coffee with interacted diversity of mixed cropping systems (false banana, sugar cane, sweet potato, Irish potato, maize, sorghum, cabbages) combined with apiculture (Mekuria et al., 2004).

Assessment of coffee berry disease (CBD)

Figure 2. Coffee berry disease shown on selective variety of coffee tree at growing site of Dilla town of Gedeo Woredas at 2013.

Figure 3. Coffee berry disease shown on coffee tree at growing site of Wonago of Gedeo Woredas 2013.

Figure 4. Coffee berry disease shown on selective variety of coffee tree at growing site of Yirgachefe of Gedeo Woredas at 2013.

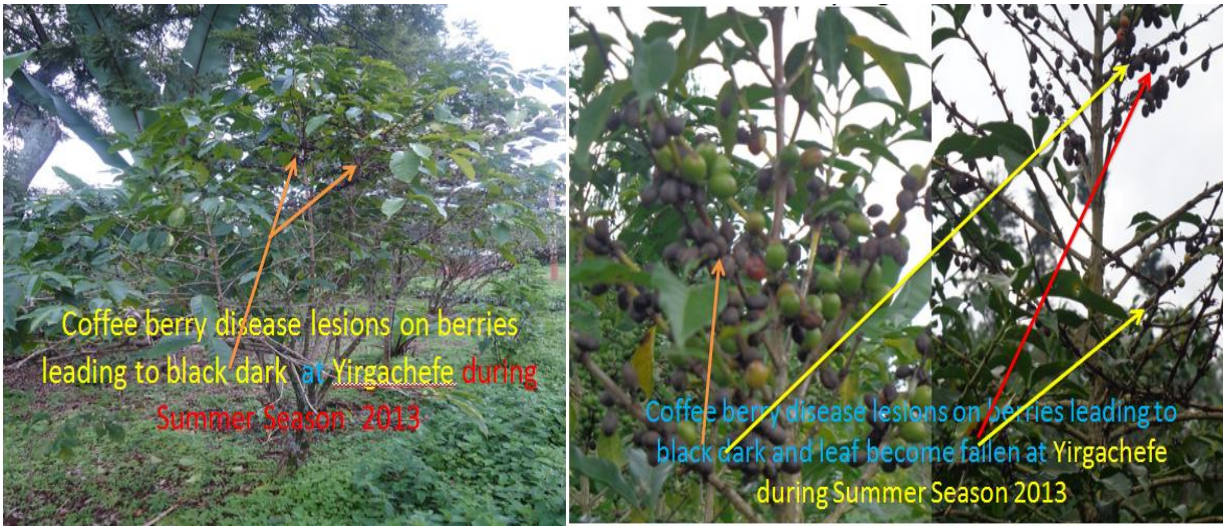


Figure 5. Coffee berry disease shown on selective variety of coffee tree at growing site of Kocher of Gedeo Woredas at 2013.

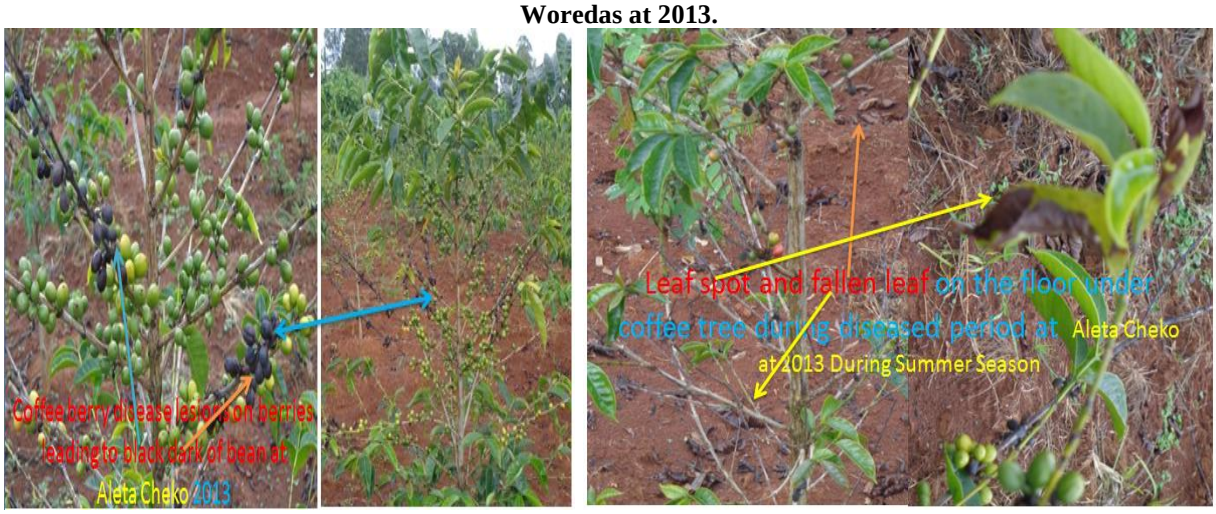


Figure 7. Coffee growing site of selective variety of coffee at Aleta Cheko of Sidama Woredas 2013, during summer season

Figure 8. Coffee berry disease shown on selective variety of coffee tree at growing site of Yirgalem of Sidama Woredas at 2013

Figure 9. Coffee seedling site of selective varietyof coffee at Yirgalem of Sidama Woredas at 2013, during summer season, this seedling coffee is more or less free from disease of Coffee berry disease

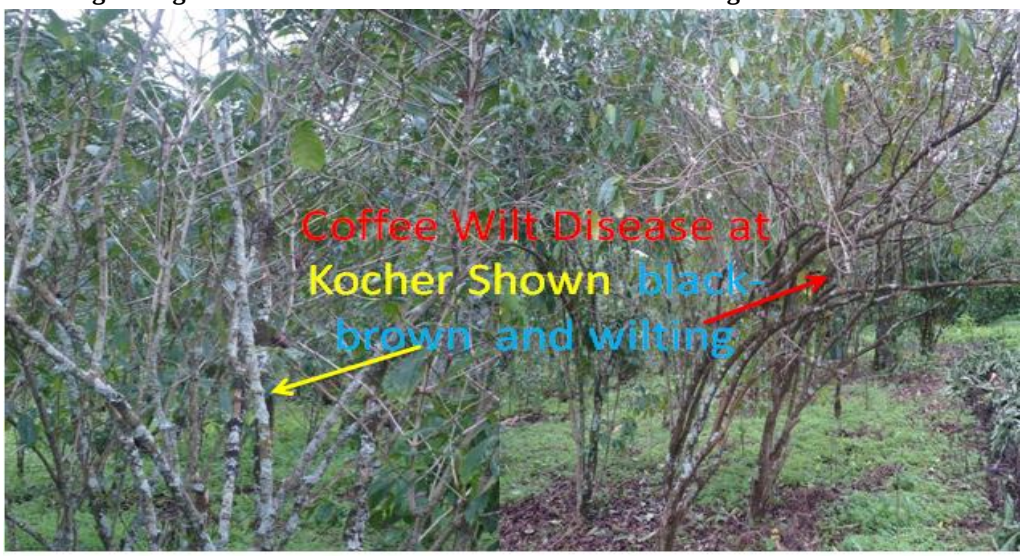
As indicated above in fig 2, 3, 4, 5, 6, 7, and 8, are infected their bean (berry) and leaf by *Colletotrichum kahawae* fungi which cause coffee berry disease. The coffee scab lesions also develop when weather conditions are not favourable for disease development, during, the weather becomes dry and hot, and on unsprayed coffee. Coffee berry disease attacks the berries, at all stages of the crop from flower to ripe berry, and the most damage is inflicted when young, expanding berries are infected, which are mostly shed once they become diseased. When the infection reaches the beans, they become black and distorted and are unmarketable. The spores are spread by rain during showers through washed down from infected berries and bark at the top of the tree to infect berries further down. In addition rain-splash can disseminate spores to adjacent coffee crop tree when droplets fall into small pools of water on the ground or on coffee crop tree. Active lesions develop on the berry and expand until the whole berry is affected. The beans are destroyed and the berries turn black and either drop or remain on the coffee plant as mummified berries. Some of the berries drop off after developing a few active lesions. The symptom of CBD is the development of small, water-soaked lesions on young, expanding berries that rapidly become dark brown or black and slightly sunken. They enlarge to cover the whole berry within about a week, which eventually fruit rots. According to some official farmers tell us, under high humid conditions, masses of pale pink spores become visible on the surface of lesions and the incidence was increased. Another characteristic of the disease is the shedding of berries from branches at an early stage of disease development. Lesions may also occur on young berry stalks, causing them to be shed before lesions appear on the berry itself. Coffee berry disease is the disease of local variety during past years. But, now day it also disease of selective variety of coffee tree, since the selective variety is also infected by disease. CBD can also cause a 'brown blight'on ripening berries, denoted by dark, sunken lesions typical

of the anthracnose enveloping the red berry. Under very wet weather conditions CBD may also cause brown lesions to develop on flower petals. In addition, it can attack seedling hypocotyls of *C. arabica*. Similarly, the symptomatology of infection caused by *Colletotrichum* species varies depending on host plant and host tissue (Waller, 1992), infection of above ground plant parts, leaves, young tissues and stems typically appears as depressed black lesions that are subcircular or angular in shape (commonly 16 known as anthracnose). More than 1000 plant species have encountered problems with anthracnose (Moriwaki et al., 2002). *Colletotrichum* spp. are also known to cause branch die-back, root rot, leaf spot, defoliation and blossom blight and rot, as well as seedling blight (Jeffries et al., 1990; Waller, 1992). The lesions enlarge, coalesce, and destroy large areas, frequently around the edges of leaves, which cause leaf curling in cases of severe infection (Dodd et al., 1992). Secondary leaf fall is considered to be the main problem of senescent rubber trees (Waller, 1992; Guyot and Omanda, 2005).

Assessment of coffee wilts disease (CWD)

Figure 10. Coffee tree totally affected by coffee wilt disease (*F. xylarioides*) on selective variety of coffee at growing site of Kocher of Gedeo Woredas at 2013 during summer season

Figure 11. Blue-black staining of wood beneath the bark on a section of stem affected by coffee wilt disease at growing site of Kocher of Gedeo Woredas at 2013 during summer season.



As shown above in fig 10 and 11, the coffee wilting disease are occurred on selective variety of coffee tree and resulting death of coffee tree through wilting of coffee tree and collapse the function of xylem. When the branches of coffee crops were affected turn black-brown or blackish and become dry. These symptoms were often started on the branches on one side of coffee tree but rapidly spread to the entire coffee tree. Berries on infected coffee trees turned red prematurely and appear to ripen early. The fungus was invades and blocks the water conducting system

(xylem) of the coffee tree, preventing the movement of water upwards from the roots. This was causes the shortage of water resulting the visible signs of wilting, dieback, and early ripening of berries that are associated with CWD. This similar with study of coffee wilts disease, on berries; sunken brown lesions appear at the stalk end of the berry, which can cut off the flow of nutrients to the berries, causing them to die prematurely. Dark brown lesions may also appear else where on the berries, especially where the flower was attached, which turn the infected berries red, so that they appear to ripen early (Kimani et al., 2002). The production of coffee is today severely affected by fungal wilt diseases including tracheomycosis (coffee wilt disease) caused by Fusarium xylarioides Steyaert (teleomorph: Gibberella xylarioides Heim and Saccas) (Adugna et al., 2001; Geiser et al., 2005; Serani et al., 2007; Silva et al., 2006). The disease is responsible for a reduction in the production of coffee beans and is also accompanied by severe damage and death of millions of coffee bushes (Adugna et al., 2001).

CONCLUSION

To sum up based on the Survey results showed that Coffee berry disease (CBD) was the major widespread disease of coffee in Gedeo and Sidama zone, Ethiopia. All commercial cultivars grown in the country were susceptible to Coffee berry disease (CBD). Coffee berry disease was a minor disease but with a potential to become a new epidemic. Most cropping practices were associated with low levels of Coffee berry disease severity. Coffee Wilt Disease also common disease on some farm area but it is not such burning issue as such other coffee disease. Howerver both coffee diseases were require great solution for the coffee production increase.

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