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Distribution and Status of Coffee Berry Disease in Western Oromia, Ethiopia

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Abstract

Coffee production in Ethiopia is highly restricted by diseases such as the Coffee Berry Disease (CBD) whose causal agent is the fungus Colletotrichum kahawae. This study was done to assess the prevalence, incidence, and severity of coffee berry disease in the East Wallaggaa Zone of Oromia. During survey work, 3 potential coffee-growing districts (Sasiga, Limmu, and Wayu Tuka) were used. Accordingly, 3 PAs per district and 5 coffee farms per PA were used. Totally, 45 coffee farms were used for this survey work. Data was collected on the prevalence, incidence, severity, and impact of some factors on the development of CBD. CBD was observed more in Sasiga (73.33%) followed by Wayu Tuka (53.33%) and Limmu (53.33%). High CBD incidence was recorded in Sasiga (32.89%) followed by Limmu (19.56%) and Wayu Tuka (18.22%). While the highest severity was recorded in Sasiga (4.93%) followed by Limmu (2.93%) and Wayu Tuka (2.73%). CBD has influence positively and negatively by altitude, shade tree status, host resistant, coffee age and sanitation and field management. Local farmers should be used CBD resistant coffee cultivars and recommended field management to overcome CBD pressure observed in the coffee industry. Further investigation is also needed on the influence of some factors on the development of CBD in the study area.

Keywords

Coffea arabica L., Coffee berry disease, prevalence, incidence and severity

1. Introduction

Coffee (Coffea spp.) is among the most important commodities in the tropical countries of the world [1]. Coffee is the most important stimulant beverage widely consumed in the world and is a very important source of foreign exchange for many countries. It is commercially grown in more than 10.5 million ha in 80 different countries worldwide [1]. It supports the livelihoods of approximately 125 million families in coffee-producing countries [2]. Worldwide, coffee provides a major form of cash income for millions of smallholder farmers and is a significant source of export earnings for many nations including Ethiopia [2]. Coffee belongs to the Rubiaceae family and the genus Coffea with 124 species that have been characterized [3]. Regardless of the wide genetic base of this genus, only two species are of economic importance, namely *Coffea arabica* L. and Coffea canephora P. and they have been contribute about 99% of world bean production [4].

However, coffee production in Ethiopia is highly restricted by diseases such as the Coffee Berry Disease (CBD) whose causal agent is the fungus *Colletotrichum kahawae*. Unlike other Arabica coffee diseases, CBD is still restricted to the African continent despite favourable climatic conditions in certain high altitudes. Arabica coffee growing areas of Latin America and Asia [1, 5]. *Colletotrichum kahawae* infects green berries at the rapid expansion stage (4-16 weeks after flowering) and may also attack mature berries, 28 weeks after flowering [6]. Epidemics of this disease can quickly destroy 50-80% of the developing berries on susceptible Arabica coffee cultivars during prolonged wet and cool weather conditions

[8]. With this, the current work was done to assess the distribution and status of coffee berry disease in coffee-growing areas in Western Oromia.

2. Materials and Methods

2.1 Description of study area

The assessment was done in coffee-growing areas of East Wallaggaa zone. Sasiga, Limmu, and Wayu Tuka districts were selected as coffee potential areas of the Zone.

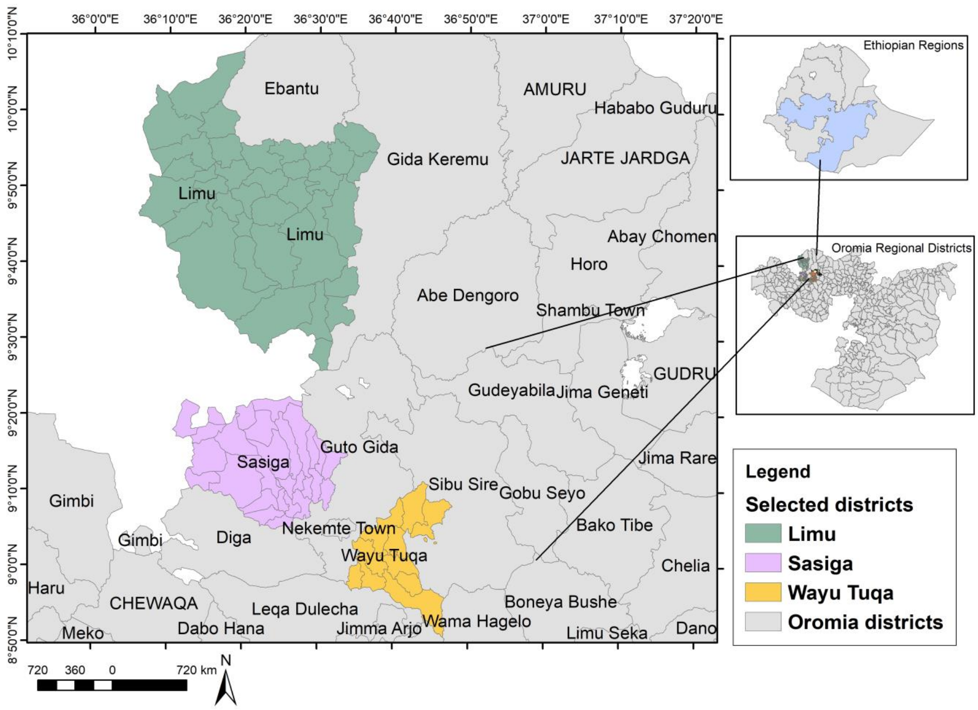

Figure 1. Map of the study area.

2.2 Sample size and methods

From each district, three PAs and five coffee farms per PA were selected in order to apply this pest assessment. Depending on farm size, five to ten coffee mother trees were used. Each coffee mother tree was stratified into top, middle, and bottom. From each stratum, a pair of representative branches was used. The following standard disease assessment methods were applied properly. CBD Incidence: thirty trees per farm were randomly taken and diagnosed visually for the presence and absence of CBD on each tree. Then after, disease incidence was calculated as (Number of diseased trees/total observed trees) x 100%. CBB Severity assessment: ten trees per farm were randomly taken and each tree was divided into three strata of branches (top, middle, and bottom). From each stratum, one pair of branches was selected to compute disease severity. CBD-damaged and healthy berries were counted and then the percentage of diseased berries over the total counted berries was calculated. CBD Prevalence: the selected farms were visually assessed for the presence and absence of CBD. Finally, disease distribution was calculated as the number of infected farms from the total assessed farms) x 100%.

3. Results and Discussions

3.1 Distributions and status of coffee berry disease in surveyed areas

3.1.1 Coffee berry disease prevalence across assessed areas

Coffee berry disease was observed in all surveyed areas (Table 1). The prevalence of CBD was recorded with no significant (p>5%) figure among and between surveyed areas. However, the disease was observed more in Sasiga (73.33%) followed by Wayu Tuka (53.33%) and Limmu (53.33%) (Table 1). The average mean of prevalence was 60% (Table 1). The variation in districts and between districts, within and between PA, and between farms was observed regards to prevalence. This none non-significant and/or different value of prevalence across surveyed areas shows the existence of factors that influence the development of *C. kahawae*. These factors may be farmers' usual practices including pruning, hoeing, uprooting susceptible hosts, avirulent pathogen, host resistance and others. The same works reported by different authors in different coffee-growing areas of Ethiopia support the obtained result. The different figure of coffee berry disease prevalence was recorded at Borena [7], Hararghe [9], and Arsi [10-12] with different rates.

3.1.2 Incidence of Coffee berry disease in assessed areas

Coffee berry disease incidence was recorded in surveyed areas with different values. That means there was no significant variation (p>5%) among and within study areas. Accordingly, a high rate of incidence was recorded in Sasiga (32.89%) followed by Limmu (19.56%) and Wayu Tuka (18.22%) (Table 1). The average mean of incidence in the surveyed area was 23.56 % (Table 1). The recorded value varied from tree to tree, within tree, within farm and farm to farm, PA to PA, within PA and within district and district to district. This dissimilarity indicates the existence of different factors which are influences the growth of the pathogen. These factors may be farmers' practices like pruning, hoeing, uprooting susceptible hosts, avirulent pathogens, host resistance and the like. According to [13] report different records in case of coffee berry disease incidence from across coffee growing areas of Oromia. Different value of CBD incidence was reported in Arsi coffee growing areas [11, 12].

3.1.3 Severity of Coffee berry disease in assessed areas

Statistically, there was no significant variation among and between districts in the case of coffee berry disease severity. However, numerical variation was obtained. The average mean severity of CBD in the surveyed area was 3.53% (Table 1). The highest severity was recorded in Sasiga (4.93%) followed by Limmu (2.93%) and Wayu Tuka (2.73%) (Table 1). This observed variation across surveyed areas indicates the presence of physical, mechanical, and biological factors which influence the growth and development of the pathogen *C. kahawae*. Among these, are climate variations, farmers' usual practices, host resistance level, and aggressiveness level of the pathogen isolates. A similar report was made in different coffee-growing areas of Ethiopia regarding CBD severity. In line with the [13] report mean CBD severity is 40.47% from Ethiopia coffee growing areas [7], 14.8% from Borena and Guji, [9] reports 38% from Hararghe, and [10, 11] 19.5% from Arsi coffee growing areas.

Table 1. Distribution and status of CBD in the surveyed area during 2020/21

Districts	Prevalence %	Severity %	Incidence %
W/Tuka	80.33	27.73	83
Sasiga	86.33	32.93	96
Limmu	74.33	12.93	38
Mean	80.33	24.53	72.33
P-value(0.05)	0.751	0.135	0.176

3.2 Influence of biological and abiotic factors on the infection rate of coffee berry disease (*Colletotrichum kahawae*) in surveyed areas

3.2.1 Influence of coffee age on the development of coffee berry disease

Coffee berry disease is influenced by coffee age. High CBD intensity was recorded from old coffee mother trees while the lowest record was made from young coffee mother trees in surveyed areas (Figure 2). As coffee of age increase the susceptibility of the coffee increasing [11]. In other case, physically, in young coffee no more canopy dense which is favor development and growth of the pathogen when compared to the oldest coffee tree. Canopy dense increase air humidity/ moisture, make low temperature and create less aeration and light penetration. This is always happened with old coffee mother tree rather than the youngest one. These agents create favourable or conducive environment for the development and growth of the pathogen.

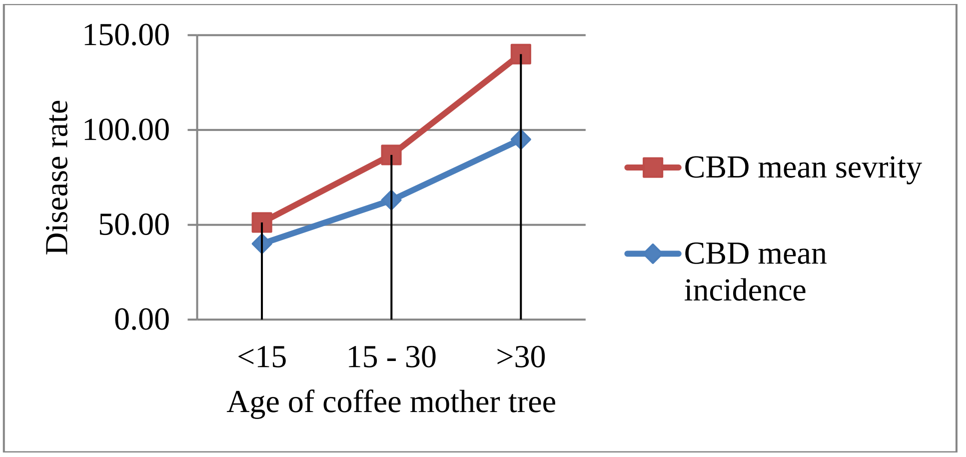

Figure 2. Impacts of coffee tree age on the development of coffee berry disease.

3.2.2 Effects of farmers’ practices on the development of coffee berry disease

Coffee berry disease severity is influenced by farmers’ practices and field management. High CBD severity was recorded with coffee farms managed poorly followed by moderately managed and managed in an advanced manner (Figure 3). Farmers' practices like pruning, shade tree regulation; using fertilizer, and weeding reduce the severity of coffee berry diseases. Whereas the reverse increases the CBD severity. Field sanitation decreases the inoculum density of the pathogen, while the reduction of disease intensity is observed [14]. Therefore, field management has an influence either positively or negatively (Figure 3). Field management including Pruning, shade tree management, using fertilizer, and weeding decreases CBD severity, whereas the reverse increases the CBD severity. CBD incidence is also influenced either positively or negatively by field management practiced by farmers.

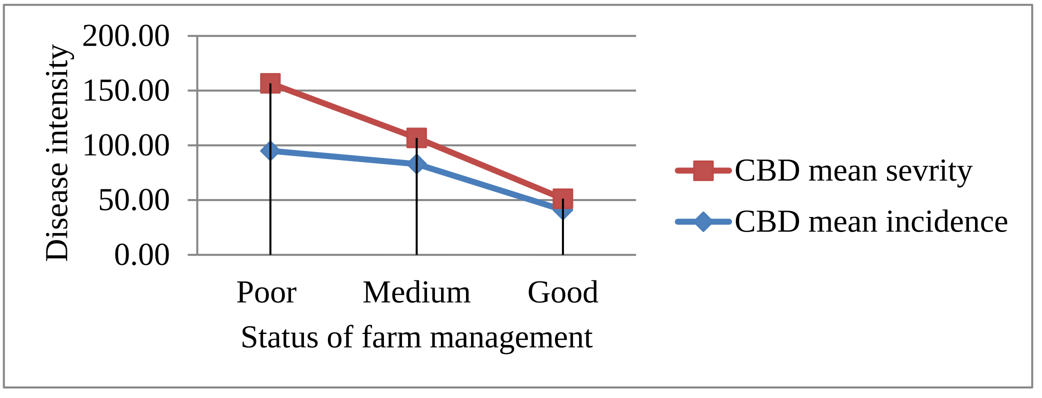

Figure 3. Status of coffee farm management and Coffee berry disease intensity.

3.2.3 Effects of elevation on coffee berry disease

Elevation has either a positive or negative influence on the development and growth of coffee berry disease causal agent *C. kahawae*. As elevation increases temperature decreases, while CBD intensity rate becomes increases. High CBD severity was recorded from coffee farms found in high altitudes followed by mid-altitude (Figure 4). Different reports revealed that coffee berry disease is more severe and causes high yield loss at high altitudes rather than mid and low land [11, 13].

CBD Incidence is also affected by elevation either positively or negatively. Accordingly, high CBD incidence was shown at high altitudes followed by mid-altitude (Figure 4). At high altitude there is a conducive environment that favours the growth and development of the pathogen. High altitude is characterized by low temperature and high relative humidity which are majorly interfered with by CBD causal agent *Colletotrichum kahawae*. In line with work high CBD severity was observed at high elevations [13]. In some coffee-growing areas of the country, high CBD intensity rate was recorded at high-land coffee growing belts [9-12].

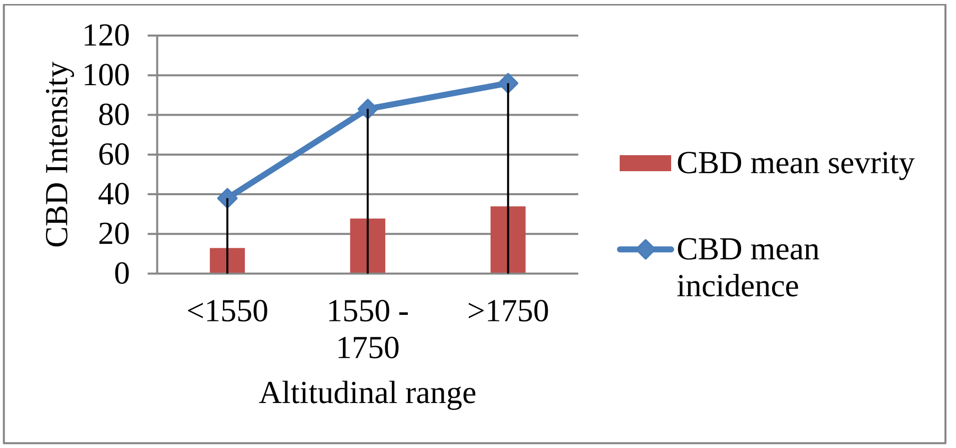

Figure 4. Effects of elevation on CBD development.

3.2.4 Influence of shade tree status on coffee berry disease development

Shade trees have their own influence on CBD severity either positively or negatively. Coffee farms under open sun were severely affected as compared to moderately shaded and shaded coffee farms. Coffee berry disease was recorded from coffee mother trees under open sun and poorly managed shade trees i.e. under coffee shade trees with too dense canopy. Not only shaded is a solution for CBD reduction unless the canopy is managed well. Poorly managed coffee shade tree dense canopy is rich with high relative humidity, cool temperature; and low aeration which is *C. kahawae* favor.

High CBD incidence was recorded from farms managed under open sun followed by moderately shaded and shaded (Figure 5). Not only shading coffee farm is influence the pathogen incidence while including the shade tree performance. So, high CBD incidence was recorded under open sun coffee farms and coffee farm trees, whereas low CBD incidence was recorded from coffee farms handled under the sun and coffee mother trees exist under shade tree there with too dense canopy. Assessments confirmed a reduction in CBD on trees grown under shade compared with those grown in full sunlight [15]. According to [6] and [13] CBD pressure is decreased in shaded coffee farms.

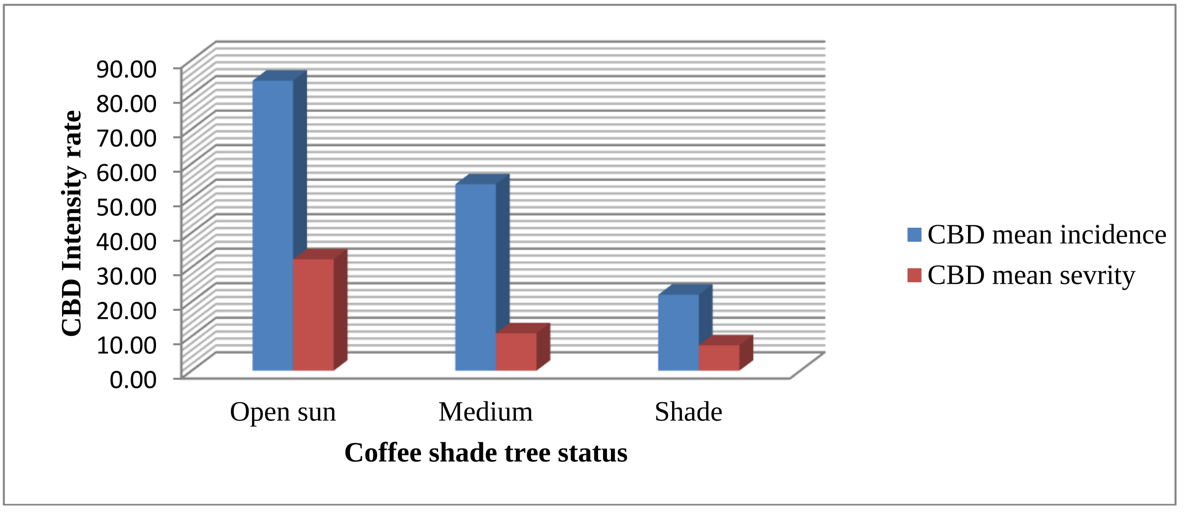

Figure 5. CBD intensity and coffee shade tree's status.

3.2.5 Impacts of host resistance level on the development of coffee berry disease

Host resistance is a major factor having a larger influence than the virulence of the pathogen races. Host resistant level has its own impact either positively or negatively on the growth and development of CBD causal agents. CBD severity was directly or indirectly influenced by the host-pathogen interaction system. During the current survey work, low CDB severity was observed with cultivars having resistant gene i.e. improved varieties (Figure 6). In this case, coffee farms with improved variety were recorded with zero value to too low rates of CBD severity. Improved varieties released some years ago were attacked a little bit by the pathogen whereas recently released improved varieties were completely incompatible with the pathogen.

The incidence of CBD could be influenced by host resistance level. Coffee farms with improved varieties and cultivars rich in resistant genes were recorded with low to zero percent CBD incidence. As indicated with below figure, depending host resistance level, 0 to 86.67% of CBD incidence was recorded. This variation was happened may be due to some reasons: among; those where incidence was 0% there is a resistance gene with host and avirulent pathogen isolates. In another case, where the value of incidence was high there is a susceptible gene with host and virulent pathogen. Similarly, where the result of incidence was recorded with intermediate value shows existence of hypersensitive cell death response. A similar report was made on the effect of host-resistant levels on CBD development [9-13]. Genetic diversity was observed on the same coffee farms in which resistant and susceptible cultivars found [9].

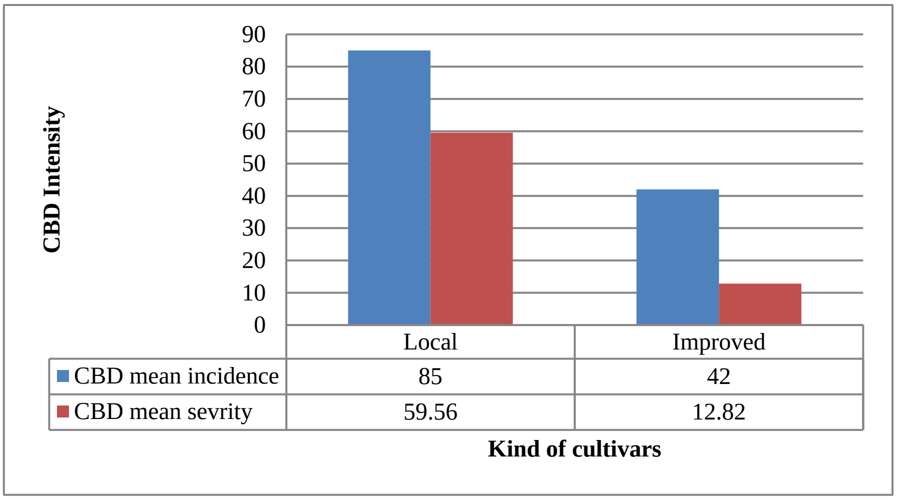

Figure 6. Host-pathogen reaction level at surveyed areas.

3.2.6 The correlation of CBD intensity with some important factors

Both coffee berry disease incidence and severity have correlated positively with some factors including altitude (r=0.25, r= 0.12), shade status (r=0.32, r=0.44), field management (r=0.42, 0.35), type of cultivars used (r=0.83) and coffee age (r=0.08; r=0.05) except negatively correlated with shade canopy dense (r= -0.18) (Table2). This result indicates that altitude, distribution of shade in coffee farms, host resistance, and coffee age have influenced positively the development and growth of coffee berry disease. While shade tree canopy dense has negatively influenced the growth and development of this disease.

Table 2. Correlation of CBD intensity with some important factors

	Altitude	Shade status	Field management	Coffee age	Shade canopy dense	Types of cultivar	CBD severity	CBD incidence
Altitude	1	-0.031	-.344*	-0.248	0.273	-.363*	0.199	0.245
Shade status		1	0.258	0.161	-.446**	.429**	.442**	.321*
Field management			1	.365*	-.344*	.425**	.350*	.417**
Coffee age				1	-0.230	.558**	0.054	0.077
Shade canopy dense					1	-.414**	-0.249	-0.181
Types of cultivar						1	.309*	0.282
CBD mean severity							1	.827**
CBD mean incidence								1

*Correlation is significant at the 0.05, **Correlation is significant at the 0.01

4. Conclusion and Recommendation

Coffee berry disease was observed at late mid to high altitude of surveyed areas. In other cases, CBD was mostly observed in the high-land coffee ecology. Coffee berry disease was highly severe in coffee-growing areas with poor shade tree performance, susceptible landraces, and poorly managed coffee farms. The growth and development of coffee berry disease has been influenced by many factors including, altitude, field management and sanitation, shade tree management, host resistance, and age. Therefore, coffee growers should use CBD resistance varieties, integrated disease management, proper/ideal field management and sanitation, and irrigation systems to overcome CBD pressure. Further management study should be made in the near future. Detail investigation regards to influence of some factors on CBD growth and development should be made in near future.

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