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Occurrence of fungal diseases of *Coffea arabica* L. in montane rainforests of Ethiopia

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Summary

Coffee Berry Disease (CBD), *Colletotrichum kahawae*, Coffee Wilt Disease (CWD), *Gibberella xylarioides* and Coffee Leaf Rust (CLR), *Hemileia vastatrix* are the three major diseases reducing production and consumption of coffee in Ethiopia. A survey was conducted from July to September 2005 for CBD and CWD and from 2003 until 2007 for CLR in montane rainforest coffee areas of Ethiopia to estimate the occurrence and distribution of these diseases. Diseases were prevalent in all the surveyed forest coffee areas of Ethiopia: Harenna, Bonga, Berhane-Kontir and Yayu. Depending on the forest coffee area the mean percent incidence of CBD ranged from 2 to 40 % in general and from 2 to 17.9 % at Berhane-Kontir and Bonga, respectively. The mean incidence of CWD varied from 2.4 % at Berhane-Kontir to 16.9 % at Yayu forest coffee areas. The mean incidence of CLR also varied for instance in 2005 from 32.2 % at Berhane-Kontir to 96 % at Harenna forest coffee areas. The detection of the diseases during our surveys requires an integrated management of major coffee diseases for a sustainable conservation and wise use of coffee in montane rainforests of Ethiopia.

Introduction

Coffee is the most important commodity crop in Ethiopia. Current contributions of coffee provide more than 60 % of the country's foreign exchange earning over 5 % of the GDP, 12 % of the agricultural output and 10 % of the government revenues (CSA, 2002). Coffee production systems in Ethiopia are grouped into four broad categories, namely forest coffee, semi-forest coffee, garden coffee and coffee plantations with an average production of 10, 34, 35 and 21 % of the total production, respectively (MCTD, 1992).

Many abiotic and biotic stresses are the major constraints of the coffee production in the country. The most important ones are fungal diseases that attack fruits, leaves, stems and roots and reduce the yield and marketability (DERSO, 1997). The major coffee diseases in Ethiopia are Coffee Berry Disease, CBD, Coffee Wilt Disease, CWD and Coffee Leaf Rust, CLR (HINDORF, 1998) .

CBD is a disease caused by the fungal pathogen *Colletotrichum kahawae* Waller & Bridge, inducing an anthracnose of green and ripe coffee cherries. The variation in frequency of CBD from one area to the other in garden coffee and coffee plantation systems was reported by many authors (IAR, 1997; BIRATU, 1995; TESFAYE and SOKAR, 2000; JIRATA and ASSEFA, 2000; TESFAYE and ABATE, 2000). DERSO (1997) estimated the overall national loss due to CBD on landraces between 24 and 30 %. Also the presence of resistant cultivars was reported (VAN DER GRAAFF, 1981).

CWD is a vascular wilt disease syndrome, commonly referred to as tracheomycosis and induced by *Gibberella xylarioides* Heim & Saccas. CWD is known to attack all species of *Coffea* including the wild indigenous lines in Tropical Africa (WRIGLEY, 1988; COSTE, 1992). The disease was reported to be prevalent on *Coffea excelsa* in the Central African Republic and Cameroon, on Robusta varieties in Zaire and Ivory Coast (BOOTH, 1971; COSTE, 1992) and found on Arabica coffee in Ethiopia, mainly in plantations near Agaro, Jimma and Bonga in the early 1970's (KRANZ and MOGK, 1973).

CLR caused by *Hemileia vastatrix* Berkeley & Broome, was firstly reported in Ethiopia in 1934 (SYLVAIN, 1955). According to WONDIMU (1991) the importance of CLR is increasing with an estimated national percent tree attack of 12.9 % which raised to 36 % after ten years.

An integrated disease management approach of forest coffee is required to conserve and use forest coffee sustainability in Ethiopia. However, there exists very little background information on major coffee disease frequencies in the montane rainforest coffee of Ethiopia.

Therefore, the main objective of the surveys was to estimate the frequency of CBD, CWD and CLR across 4 montane rainforest coffee areas of Ethiopia. These forest coffee areas contain a large genetic pool of Arabica coffee representing a potential source for the benefit of present and future human generations.

Materials and methods

Descriptions of field sites

Disease surveys were conducted in 4 montane rainforest coffee areas in the Southeast (Harenna/Bale Mountains) and Southwest (Bonga/Kaffa, Berhane-Kontir/Bench Maji and Yayu/Illubabor) of Ethiopia (Tab. 1).

Tab. 1: Description of the study sites in montane rainforests of southwestern Ethiopia.

Forest area	Altitude (m)	Co-ordinates	
		Latitude(N)	Longitude (E)
Harenna	1400 - 1700	6° 30'	39° 45'
Berhane-Kontir	1100 - 1200	7° 06'	35° 26'
Bonga	1600 - 1900	7° 19'	35° 03'
Yayu	1400 - 1800	8° 23'	35° 47'

Assessment of Coffee Berry Disease (CBD)

In each forest coffee area, CBD assessments were taken in 5-7 plots across the forest coffee by considering the existing field variation, especially land gradients, presence and absence of forest coffee. In each 100 x 100 m plot assessments were conducted on the same trees diagonally following procedures used by TESFAYE and SOKAR (2000). In visual assessments 10 trees/plot were randomly taken and diagnosed for presence and absence of the disease frequency on each tree. Thereafter disease frequency was calculated as the number of diseased trees divided by total observed trees x 100.

Assessment of Coffee Wilt Disease (CWD)

In each forest coffee area CWD assessments were taken in 5-8 plots across the forest coffee area. In each 100 x 100 m plot, 30-50 trees were diagnosed diagonally and consecutively following the procedure

of ADUGNA et al. (2001) and CABI (2003). Healthy and diseased dying or dead trees, showing typical characteristic internal and external symptoms of the disease and/or sign of the pathogen, were visually observed and recorded. Internal symptoms like black and/or brown stripes were observed after scratching off the bark of diseased trees to expose the wood for proving the causal agent. Then the numbers of healthy and diseased trees were counted and the incidence of CWD was computed as the number of diseased trees divided by the total number of observed coffee trees x 100.

Assessment of Coffee Leaf Rust (CLR)

In each forest coffee area two representative sites were selected. The assessments for CLR were carried out randomly within each 100 x 100 m forest coffee area on 100 trees counting the frequency of leaf attack (%) and scoring the intensity of pustules per leave in the following scale: 1 = no pustule, 2 = 1 pustule, 3 = 2 pustules and 4 = > 3 pustules. To obtain a longer termed overview on the development of the CLR situation in montane rainforests we include data scored since 2003 in the same way.

Data analyses

Excel microcomputer statistical software was employed to design graphs.

Results and discussion

The three major diseases of coffee, namely coffee berry disease (CBD), coffee wilt disease (CWD) and coffee leaf rust (CLR) were found in association with forest coffee in Harenna, Bonga, Berhane-Kontir and Yayu montane rainforests of Ethiopia (Fig. 1). Leaf blight, *Ascochyta tarda* Stewart and coffee bean darkening or bacterial blight, *Pseudomonas syringae* pv. *garcae* (Amaral, Teixeira & Pinheiro) Young, Dye & Wilkie were also observed in the forest coffee, but not scored during our surveys.

Occurrence of CBD in the montane rainforest coffee of Ethiopia

The frequency and intensity of CBD varied among and within forest coffee areas depending on environmental conditions like altitude, rainfall, temperature etc. and genetic diversity of the forest coffee. Survey results indicated that the disease frequency ranged from 0-50 %, 20-60 %, 0-20 % and 0-50 % and the intensity from 0-15 %, 12.5-22.5 %, 0-6.5 % and 0-7.8 % in forest coffee areas of Harenna, Bonga, Berhane-Kontir and Yayu, respectively (Fig. 1). The mean frequency ranged between 6 % at Berhane-Kontir and 40 % at Bonga, respectively. High frequencies of CBD may be explained by the particularly high rainfall found in relatively high altitudes of Bonga and to some extent in Yayu. Similarly, COOK (1975) explained that high rainfall, high humidity or wetness and relatively low temperatures persisting for long periods and favouring the CBD development are existing at higher altitudes, where these conditions generally prevail. In general our results confirmed the observations of COOK (1975) and are shown in Fig. 2. In addition to expected results in Yayu the disease was also found at low altitudes (<1500 m.a.s.l) ranging from a frequency of 0 to 40 %, but achieved a frequency upto 50 % in medium altitudes. This indicated that CBD can be very important in lower altitudes too. There occurred no CBD at low lands of Harenna (around Majete) and Berhane-Kontir (around Gizmeret) forest coffee areas. These results are the first informations in both areas for the existence of CBD infestations in limited pocket parts of Harenna (around Mekabaldo) and Berhane-Kontir (around Wesheka) forest and semi-forest coffee areas.

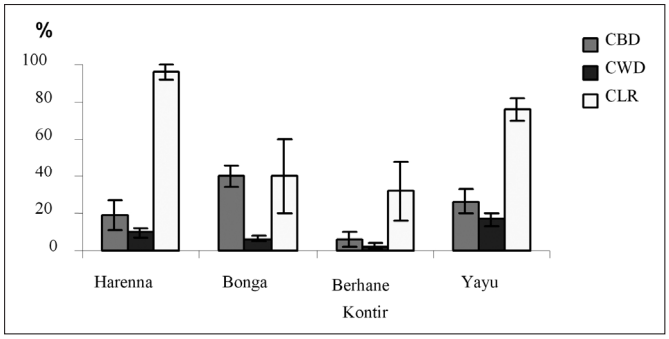


Fig. 1: Occurrence of Coffee Berry Disease (CBD), Coffee Wilt Disease (CWD) and Coffee Leaf Rust (CLR) in montane rainforest coffee of Ethiopia (error bars are standard errors).

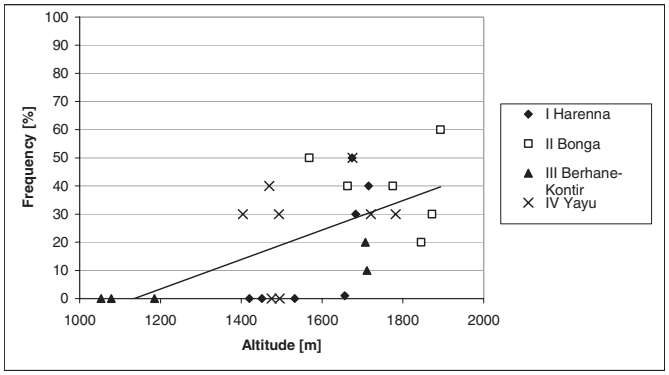


Fig. 2: Frequency of Coffee Berry Disease (CBD) in montane rainforest coffee of Ethiopia depending on altitudes

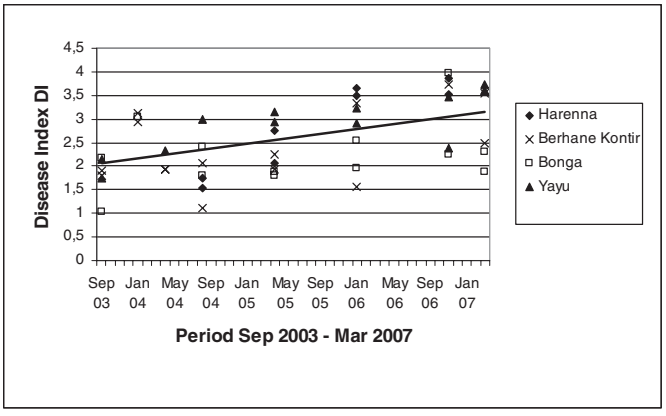
Occurrence of CWD in the montane rainforest coffee of Ethiopia

CWD was found in all assessed forest coffee areas suffering considerably in coffee tree losses. Its frequency varied from 0-16 %, 0-10 %, 0-6 % and 0-30 % in forest coffee areas of Harenna, Bonga, Berhane-Kontir and Yayu, respectively. The mean frequency varied between 2.4 % at Berhane-Kontir and 16.9 % at Yayu (Fig. 1). The disease seems to expand and damage coffee trees particularly in Yayu and Harenna. Coffee farmers in Yayu, Bonga and Harenna are accustomed to work in groups and use cutlasses (bushman knives) to slash weeds around coffee trees once per year from July to mid September and thereby occasionally coffee trees are wounded becoming then susceptible for an attack of the pathogen. The difference in genetic diversity of autochthonous Arabica coffee as well as differences in cultural practices (exposure of coffee trees to wounding) from one forest population to the other and within the same forest coffee area could be the cause of variations in the extent of CWD incidence across forest coffee areas. ADUGNA et al. (2001) also reported that CWD incidence ranged from 45 to 69 % on coffee plantation fields at Gera and Bebeka, respectively. Reports on CWD incidences on Arabica coffee in Ethiopia 49 years ago resulted in very low mean percent frequencies across the forest coffee areas as compared to the national CWD survey results of Ethiopia (CABI, 2003). Our results also showed frequency variations from one forest coffee area to others, even from one particular plot to another plot within one forest coffee population. According to BOOTH (1971) the fungus is known to penetrate coffee trees through wounds either above or below the ground. ADUGNA et al. (2001) also reported that any parts of infected trees, except seeds, and possibly the adjacent

asymptomatic coffee trees and soils serve as survival organ and could be potential sources of the pathogen for infections. In Harenna forest coffee flocks of cattles have grazed and moved along the coffee trees while damaging coffee trees, seedlings and carrying the inoculum on their bodies from area to area. In Berhane-Kontir people intensively use drying and dead coffee trees as firewood and carry this across the forest coffee areas. This could easily be a methods for distributing ascospores of the perfect stage. All the above mechanisms most probably aggravated the spread and distribution of the disease in the forest coffee and increasing damaging effects of the disease in the areas.

Occurrence of CLR in montane rainforest coffee of Ethiopia

In all investigated forest coffee areas coffee leaf rust (CLR) was prevalent to a high extent (Fig. 1). Results of the assessments, counting exactly the number of infected trees for the frequency and scoring the intensity on single infected leaves, showed more or less high frequencies of CLR in all forest coffee areas varying from 32.2 % at Berhane-Kontir to 96 % at Harenna forest coffee (Fig. 1). The highest CLR frequency occurred in 2005 at Harenna followed by Yayu. Young seedlings under the forest coffee at Harenna were covered completely with rust sori influencing the survival and further growth. In addition to the annual disease occurrence in 2005 we present data on the intensity of CLR during the complete observation period from 2003 - 2007. The tendency of an increase of the disease in all autochthonous coffee areas of Ethiopia is shown in the positive slope of the regression curve (Fig. 3).



*DI class 1: no disease; class 2: one rust pustule/leaf; class 3: two rust pustules/leaf and class 4: three and more rust pustules/leaf

Fig. 3: Intensity of Coffee Leaf Rust (CLR) from 2003 until 2007 in montane rainforest coffee of Ethiopia.

Conclusion and recommendations

Major coffee diseases such as CBD, CWD and CLR were assessed in the montane rainforest areas: Harenna (Bale Mountains), Berhane-Kontir, Bonga and Yayu. CBD frequencies varied at the areas in which forest coffee was grown depending on environmental conditions and genetic diversities of the forest coffee.

The mean percentage of CBD varied from 6 to 40 % and 2 to 17.9 % at Berhane-Kontir and Bonga, respectively. Results of these surveys showed that CBD widely occurred in Bonga forest coffee areas followed by the disease distribution in Yayu.

CWD was prevalent in all assessed forest coffee areas, where it has achieved already considerable coffee tree losses. Its mean frequency ranged from 2.4 % at Berhane-Kontir forest area to 16.9 % at Yayu forest coffee area with certain variations among sampled forest coffee field plots in each forest coffee locality. Differences in genetic diversity of autochthonous Arabica coffee as well as the variations in the intensity of cultural practices from one forest population to the other and within the same forest coffee population could be the cause of the extent of CWD frequencies across forest coffee areas. Even though CWD was reported in earlier times 49 years ago occurring on Arabica coffee in Ethiopia, our survey results showed very low mean percentage of disease frequencies across the forest coffee areas due to a possible high diversity among autochthonous forest coffee germplasms and low cultural practices in these forest coffee areas.

In all assessed forest coffee localities CLR occurred more or less frequently attacking up to 96 % of the trees with an increasing tendency during the last 5 years.

The observations on the presence of all three major fungal diseases in the autochthonous coffee of montane rainforests in Ethiopia need a careful integrated management of the diseases for sustainable conservation and wise use of the forest coffee gene-poole with its still high diversity (CoCE I, 2007).

Acknowledgements

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