

*Full Length Research Paper*

# Incidence and severity of coffee leaf rust and other coffee pests and diseases in Rwanda

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**Coffee Leaf Rust (CLR) caused by *Hemileia vastatrix* Berk. and Br. has a worldwide distribution and causes enormous yield losses. A survey was conducted in Rwanda to evaluate incidence and severity of CLR and other coffee pests and diseases and to determine how the crop management contributes to CLR severity. A stratified random sample of 307 coffee farms was visited and the prevalence, incidence and severity were recorded. Results showed that all provinces were affected by CLR with the highest severity in Eastern province where the incidence was up to 100%. High altitudes were associated with low disease severity with a negative correlation of - 0.71. Coffee berry disease (CBD) was a minor disease but with a potential to become an epidemic in the future. Coffee leaf miner, Antestia bugs and Coffee stem borer were recorded but were managed below economic injury levels. All commercial cultivars were susceptible to CLR and most management practices such as mulching, pruning and fertilizer application were associated with lower levels of CLR severity except intercropping which resulted in higher disease intensity. Implications of this survey in relation to CLR management in Rwanda are discussed in this study.**

**Key words:** Coffee, diseases, incidence, severity, management, Rwanda.

## INTRODUCTION

Coffee is an important export crop and a major foreign exchange earner for Rwanda. It is the second most important agricultural export commodity after tea earning in the country having over 15% of the foreign currency annually (Anonymous, 2009). The crop provides direct employment to a considerable number of workers and it also does well on hillside farms where other more demanding cash crops are not easily grown.

Coffee suffers yield losses from a number of factors including insect pests and diseases. Among these, Coffee leaf rust (CLR) caused by *Hemileia vastatrix* Berk. and Br is the most devastating. Yield losses per year due to CLR range from 30 to 90% depending on the environmental conditions during a given year, especially, if not properly controlled by an intensive program of fungicides

spray (Sera et al, 2005). In Rwanda, the situation is worsened by varieties grown in the country most of which are Bourbon type that is, Jackson, Mibilizi and Bourbon Mayaguez which are mostly susceptible to CLR. An effort was undertaken by the government of Rwanda under the support of the Common Funds for Commodities (CFC) through CAB International to test the Indian hybrids and the most promising coffee germplasm. The intention was to come up with the best varieties, establishment methods and their best growing conditions. However, there was very little background information available on the distribution and severity of CLR in Rwanda and there were no documented records. As part of a project to obtain baseline information for the development of suitable interventions for the management of the disease, a survey was conducted in the coffee growing regions with the following objectives: 1) to evaluate incidence and severity of CLR and other diseases in Rwanda and 2) to determine how various crop management practices contribute to the disease severity.

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**Table 1.** Distribution of surveyed farms per province.

Provinces	Number of farms
Western	92
Southern	97
Northern	30
Eastern	77
Kigali	11
Total	307

**Table 2.** Distribution of CLR in surveyed Provinces.

Province	% of farms with CLR	Standard error
North	83.3	6.2
East	97.4	8.3
South	92.2	2.6
West	94.3	2.6
Kigali	94.6	2.8

## MATERIALS AND METHODS

### Survey methods

A stratified random sample of three hundred and seven coffee farms were selected for a disease survey from a list of coffee growers held by Rwanda Coffee Development Authority (OCIR Café). The number of farms surveyed per province is presented in Table 1. The survey was carried out in Western province, mainly the shores of Lake Kivu, the Northern province covering the border with Uganda to Lake Muhazi, the Southern province from near the city of Kigali to Burundi and in the Eastern province from the central part to the border with Tanzania.

Farms were surveyed from June to August, 2008. For each farm visited, 30 bushes were scored on a diagonal line across the farm for the presence or absence of symptoms of CLR and Coffee berry disease (CBD) caused by *Colletotrichum kahawae*, Waller and Bridge and other pests and diseases. Disease prevalence (percentage of farms where the disease was recorded), incidence (percentage of bushes affected per farm) as well as, severity were recorded. The incidence of CLR and CBD were scored on each of the coffee tree using the following scale: 0 = no disease, 1 = < 10% diseased leaves (CLR) or berries (CBD), 2 = 10 to 30% diseased leaves or berries and 3 = > 30% diseased leaves or berries (Phiri et al., 2001). Severity was recorded as an average number of pustules per leaf for CLR and the average number of lesions per berry for CBD. Other coffee diseases and pests were recorded as either present or absent.

At each farm, a questionnaire was administered and the owner was asked about the age of the bushes, if fertilizer or pesticides were applied and if so, which types were applied, if the plantation was weeded and whether bushes were pruned. This information was collected from each farmer. In addition, it was confirmed by our own observation, particularly, in the case of weeding and pruning. Information was also collected on whether shade trees were used and whether the coffee was intercropped. Altitude in metres above sea level (masl) was taken, using a Garmin Ground Positioning System (GPS) at a central point for each farm surveyed. Data collected on incidence, severity and prevalence were summarized as means for all farms surveyed and standard errors were calculated.

Data were also analyzed for correlations between severity of CLR and altitude. Multiple linear regression analysis was used to determine the relationship between management practices and CLR severity using GenStat Discovery Edition 3 (2007).

## RESULTS

### Altitude

The altitude of surveyed farms varied considerably with regions surveyed. The highest altitudes were recorded in the Northern province with the average of 1902.6 masl while the lowest altitudes were found in the Eastern province with the mean altitude of 1564.6 masl. The highest altitude point measured was 2045 masl while the lowest point was 1211 masl. Altitude was found to have an implication on the distribution and severity of CLR since the relationship between the disease severity and the altitude was quite apparent during the survey period.

### Coffee leaf rust distribution and severity

The survey data showed a wide distribution of CLR in Rwanda (Table 2). All surveyed provinces had the disease ranging from about 80% of surveyed coffee bushes to more than 95%. The highest CLR incidence and severity were recorded in Eastern province while the lowest were observed in the Northern province. The coffee rust incidence, measured as the percentage of diseased leaves per coffee bush, ranged from 0 to 100% in surveyed farms. Results also showed that only 15% of surveyed farms were not diseased. The remaining farms had varying levels of disease incidence (Figure 1).

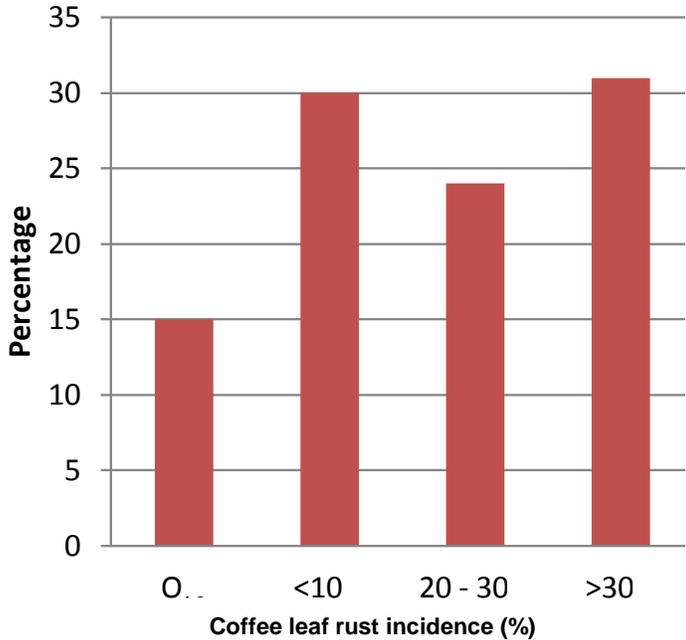


Figure 1. Percentage of farms infected by CLR in Rwanda.

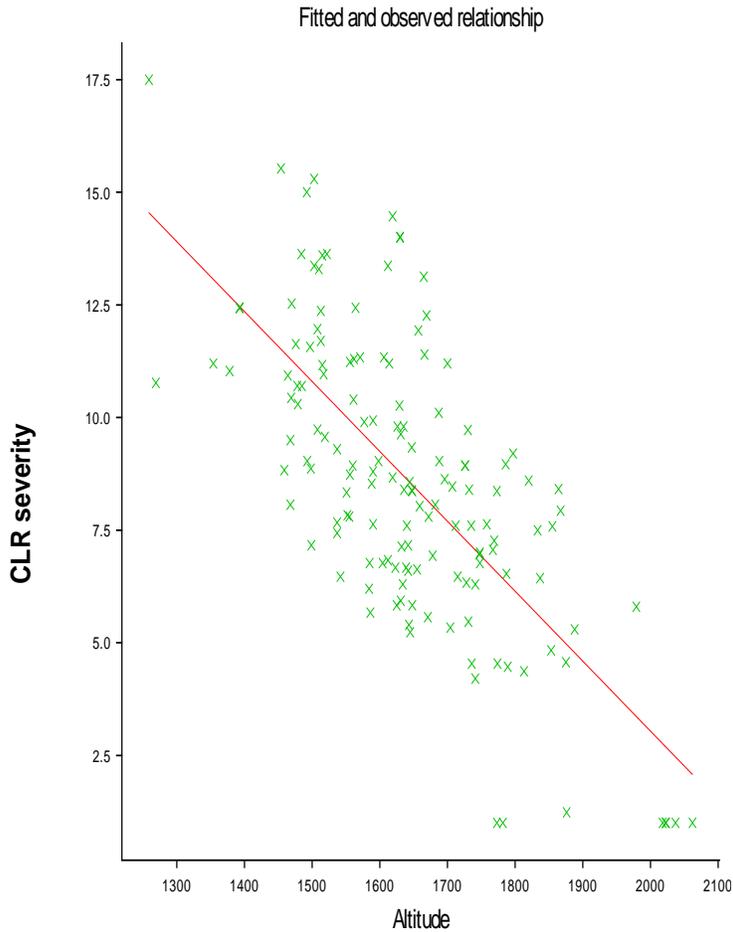


Figure 2. Relationship between CLR severity and altitude.

**Table 3.** Prevalence of notable coffee pests on surveyed farms.

Province	% of farms with CLM	% of farms with Antestia	% of farms with CSB
West	26.2	0.1	0
North	37.9	6.6	0
East	20.4	0	1.6
South	2.4	2.9	0
Kigali	2.6	0	0

### Relationship between coffee leaf rust severity and altitudes

The survey data showed a negative correlation between CLR severity and altitude ( $r = - 0.71$ ). The disease severity decreased when altitude increased (Figure 2). As was noticeable during the survey period, farms located at higher altitudes (normally from 1800 masl and above) had less CLR and those at lower altitudes (mainly from 1400 masl and below) were much more diseased. The linear regression equation was found to be:

$$Y = - 0.0155 X + 34.093$$

Where Y is the disease severity and X the altitude (Figure 2). Both slope and intercept were highly significant at ( $p < 0.001$ ).

### Distribution and severity of coffee berry disease

During the survey period, there was no CBD recorded as it was during the dry season.

### Notable pests

Coffee leaf miner (CLM) caused by *Leucoptera coffeella* was recorded in all surveyed provinces (Table 3). The highest percentage of farms infested with CLM was found in the Northern province with more than 35% of surveyed coffee bushes. In the Southern province and Kigali respectively, the number of infested coffee bushes was low (less than 5%). Antestia bug (*Antestiopsis lineaticollis*) was also a major pest recorded in the surveyed area. The highest number of coffee bushes infested by the pest was found in the Northern province with more than 5% of infested farms. In the Southern province and Kigali, there was no Antestia bugs recorded on surveyed farms. Coffee stem borer (CSB) was found in the Eastern province, mainly on old coffee trees where the number of infested coffee bushes was less than 2%. In other surveyed provinces, there was no CSB that was recorded. At national level, only CLM appeared important with the prevalence going up to 22% while it was 2.9 and 0.2% for Antestia and CSB, respectively.

### Relationships between management practices and CLR severity

In all surveyed areas, intercropping was found to be practiced to a limited extent that is, less than 10% (Figure 3). Intercrops were sweet potatoes, yams, cassava and bananas. Farms which were intercropped had significantly ( $p < 0.001$ ) higher CLR severity than non-intercropped farms. It was also found that more than 70% of surveyed farms were mulched and the mulching mainly comprised of banana leaves, sorghum and rice straws. The effect of mulch on the severity of CLR was highly significant in surveyed farms at ( $P < 0.001$ ). More than 95% of surveyed farms were weeded and the weeding was done mainly with hoe especially, in non-mulched coffee farms. Weeds were also uprooted by hand in mulched coffee farms. No herbicide was used in surveyed areas. Farms which were weeded had very significantly lower CLR severity than unweeded farms having a value of ( $p < 0.001$ ).

Pruning was found to be practiced at 89.2% in farms where the survey was carried out. Coffee bushes which were pruned had significantly less CLR severity than where bushes were not pruned ( $P < 0.001$ ). Similarly, farms which were fertilized had significantly lower CLR severity than unfertilized farms ( $p < 0.001$ ). Applied fertilizer was either organic (compost made of crop residues and farm yard manure) or inorganic (mainly a combination of nitrogen, phosphorus and potassium to NPK 20 - 10 - 10). Unlike other cropping practices for which management was at a very high level (more than 85%), less than 60% of surveyed farms were fertilized.

The results did not show any relationship between age of coffee trees and CLR severity and coffee trees of different ages suffered heavy CLR infection equally.

### Status of commercial cultivars in relation to CLR resistance

There were six varieties of coffee bushes recorded during the survey. These were Bourbon Mayaguez 139 (BM 139), BM 71, Jackson 2/1257, Harar, Pop 3303/21 and Mibilizi. All of these varieties were susceptible to CLR. In all surveyed areas, an average of over two pustules per leaf was observed on all cultivars. The analysis of variance

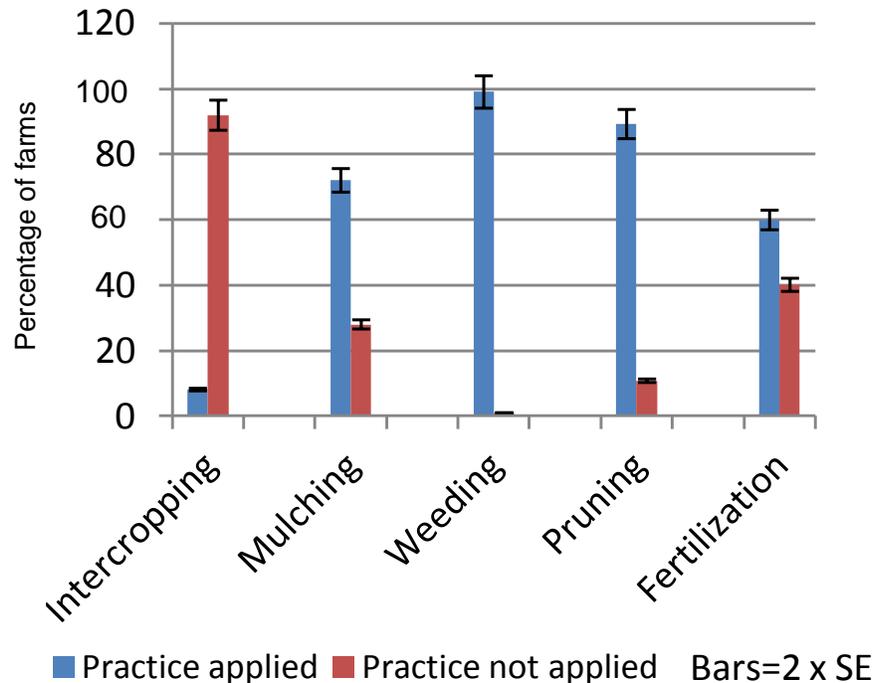


Figure 3. Level of management practices in surveyed farms.

did not reveal any significant difference between the above varieties ( $p = 0.08$ ) in regards to CLR severity and therefore all cultivars exhibited equal susceptibility.

## DISCUSSION

### Coffee leaf rust

It is apparent from this survey that CLR is widespread throughout the country with the incidence increasing as much as 100% in certain areas. This may partly be explained by climatic conditions prevailing in Rwanda. The alternating wet and dry conditions favor high CLR build up and thus leads to high crop losses (Prakash et al., 2005). On the other hand, this high disease incidence is also compounded by the high susceptibility of commercial cultivars grown in the country. It is worth mentioning that in all provinces and on all varieties, more than two pustules per leaf were recorded.

According to Anonymous (1989), two to three pustules per leaf are required to produce severe leaf defoliation on heavily bearing coffee and can cause die back and biennial bearing, a situation which was already noticeable in certain areas during the survey period. The disease severity has reached such destructive proportions that it is repeatedly causing great concern among both farmers and government. A need therefore, exists to develop CLR resistant varieties with adequate cup quality and local adaptability to coffee growing conditions. Meanwhile,

since copper based fungicides have been effective for the control of coffee rust, the program of timely spraying with such fungicides should also be adopted as a short-term measure.

### Coffee berry disease

The survey results did not show any case of CBD infection. One possible reason is because the survey was carried out during the dry season. Griffiths and Waller (1971) found that the occurrence of CBD in Kenya was related to high rainfall and altitude. Though high altitudes (> 1800 masl) were recorded in this survey, it was conducted during the period of very low relative humidity. Water is a requirement for the development, dispersal and germination of *C. kahawae* conidia. It was observed, however, that most of the recommended coffee varieties in Rwanda are uniformly susceptible to CBD (Walyaro, 2010). Though currently a minor disease, it has the potential to flare up into a major epidemic any time. The coffee breeding program should, not only develop varieties that are resistant to CLR, but also to both CLR and CBD in light of the climate changes occurring around the world.

### CLR severity and altitudes

The results showed a negative correlation between CLR

severity and altitudes. The negative correlation was also reported by Kushalappa and Eskes (1989) who found that higher altitudes were associated with lower disease severity. Rivera (1984) also observed a lower level of disease intensity at higher altitudes in Guatemala. This finding prioritizes higher lying areas as more deserving of efforts to develop CLR resistant varieties with adaptability to such conditions.

### Notable pests

CLM was observed in all surveyed areas. The highest prevalence was recorded in the Northern Province (37%) probably because of conducive climatic conditions of the zone. Oliveira (2006) reported that temperature of around 27°C and nearly saturated relative humidity favoured high pest build up and this closely reflected the environmental conditions of the Northern province during the survey period. Though widespread, CLM has not yet reached economic proportions to necessitate control but its potential to grow into an important pest within a short time remains real considering the levels observed.

Antestia bugs were recorded in the Northern, Western and Southern provinces at relatively low levels (less than 6.6%). This pest was not recorded on coffee bushes in the Eastern province and Kigali. This may be explained by regular pruning since this agricultural practice reduces dense foliage and hence, creates unfavorable conditions for the bugs. In addition, general use of Dursban (Chlorpyrifos) whose wide use was recorded may also be the source of low level of Antestia bugs recorded.

### Management practices and CLR severity

Weeding, pruning and mulching are common cultural practices across all provinces unlike the significantly low use of fertilizers. Most farmers were smallholders lacking resources to afford fertilizers. Moreover, coffee faced a stiff competition from the staple crops in regards to organic fertilizer utilization. Results have showed that all cropping practices except intercropping resulted in reduced CLR severity. Both weeding and fertilization increased the plant vigor and made it tolerant to CLR attack. Mulching, in addition to providing organic matter, also adequately conserved soil moisture. Intercrops competed with coffee bushes for water, nutrients and light which resulted in higher CLR severity.

### CONCLUSION AND RECOMMENDATIONS

Survey results showed that CLR was a widespread disease in Rwanda. All commercial cultivars grown in the country were susceptible to CLR. Coffee berry disease was a minor disease but with a potential to become a new epidemic. Recorded pests were CLM, Antestia bugs,

and CSB but these were managed below economic injury levels. However, continued monitoring of the pests occurrence was recommended as it is likely to be closely associated with seasonal conditions and the important elements that are likely to be associated with global warming. Most cropping practices were associated with low levels of CLR severity except intercropping which resulted into higher disease intensity. Given the susceptibility of commercial cultivars, there is the need to develop varieties that are resistant to both CLR and CBD.

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