Incidence of Corynespora Leaf Fall Disease of rubber in the main growing areas of Côte d'Ivoire

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1 ABSTRACT

Corynespora Leaf Fall Disease (CLFD) poses a real threat to natural rubber production in the world. It causes natural rubber production losses of the order of 20 to 25%. Observed for the first time in Côte d'Ivoire in 1989, it has recently reached epidemic proportions. The objective of this work is to carry out investigations in the rubber fields of Côte d'Ivoire, in order to evaluate the incidence of Corynespora Leaf Fall Disease in the main areas of natural rubber production. The results of the survey in six rubber growing areas revealed, in 2018, the presence of CLFD in five, in particular the South-west (Grand Bereby, San Pedro, Sassandra), South (Anguédédou, Dabou, Grand-Lahou, Sikensi et Tiassale), Central-west (Gagnoa, Issia, Soubré), East (Abengourou, Alepé, Daoukro) and South-east (Aboisso, Adiaké, Bonoua et Tiapoum) with incidence rates between 8 and 22%. Only, the western zone (Blolequin, Guiglo, and Toulepleu) remained free from disease. Higher incidence rates were observed in the south-west and south-east of the country. Among the clones observed, IRCA 18 was the most affected by CLFD, with disease incidence rates estimated at 74%, followed by polyclone plantations (24%) and the clone PB 260 (2%). High incidence of CLFD was noted in young plantations (72%) when compared with older plantations (5%).

2 INTRODUCTION

Corynespora Leaf Fall Disease (CLFD) is a rubber tree disease caused by *Corynespora cassiicola* (Berk. and Curt.) Wei (Ramakrishnan and Pillay, 1961). This fungus causes necrotic lesions on the rubber leaves with blackening of the veins giving a profile of "fishbone" (Ramakrishnan and Pillay, 1961). These typical symptoms on rubber are observed on both young and mature plants (Dung and Hoan, 2000). Repeated defoliations due to this disease weaken the tree and strongly impact rubber production as the rubber synthesis is closely related to the photosynthetic activity of the leaves. This foliar disease was therefore classified by the IRRDB as the 4th major problem of rubber plantations in 1994, in terms of financial loss, (Jayasinghe, 2000). It causes natural rubber production losses of the order of 20 to 25% (Barthe, 2007). Initially confined to nurseries, the CLFD extended to young plants and then to mature trees in certain localities of India during the years 1969 to 1976 (George and Edathil, 1980). It is today, a real threat for the world rubber industry (Jayasinghe 2000, 2003). The severe form of this epidemic first appeared in Sri Lanka between 1985 and 1986 on the clone RRIC 103 (Liyanage *et al.*, 1986, Jayasinghe, 1997) and in Thailand in 1985 (Kajornchaiakul, 1987). The first epidemic outbreaks in Africa were observed in Nigeria in 1966 in the western, central-western and eastern states (Awoderu, 1969) on clones GT 1, RRIM 600 as well as several Nigerian clones (Begho, 2000). In Côte d'Ivoire, a high incidence of *Corynespora cassiicola* disease was reported for the first time in 1989 on the clone RRIC 103; this clone was immediately eradicated (Wahounou *et*

al., 1996). Later, attacks of *C. cassiicola* have been recorded on clone IRCA 18, resulting in considerable economic loss (Wahounou *et al*., 2011). It is therefore important to assess the disease incidence in the rubber plantations in order to recommend control methods. This study was conducted to assess the incidence and distribution of CLFD across the Ivorian rubber plantations.

3 MATERIALS AND METHODS

3.1 Choice of surveyed plantations: The survey on CLFD was carried out in all the natural rubber-producing regions of Côte d'Ivoire (Figure 1). During this study, two types of plantation were explored- village plantations and industrial plantations. For village producers, the sampling frame used consisted of lists of producers by region and by industrial structure. For the industrial sector, the list of agro-industrial blocks served as a sampling frame. These lists were provided by the organizations of the rubber planters. The survey covered plantations of all clones and all ages throughout the rubber plantations. Thus, six strata or regions were formed (Table 1). The overall sample size was calculated according to the following formula:

$$n = \frac{4p(1-p)}{k^2 p^2} deft$$

p: Proportion of producers, whose plots have diseases,
k: Percentage of error made on the estimate of p,
deft: Fixed sample size to maintain the same precision as simple random draw.
In total, 2400 producers were involved in the survey. This sample was then distributed among the regions and then the localities in proportion to the number of planters (Table 1).

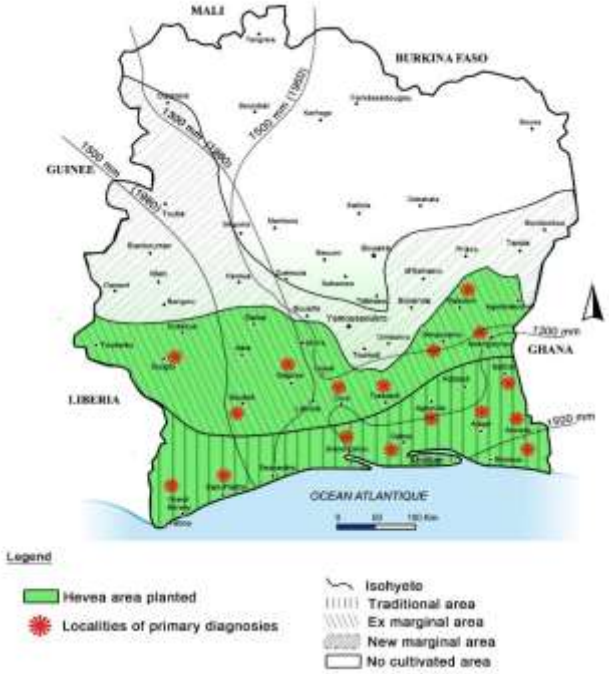

Figure 1: Map of Côte d'Ivoire indicated study areas (Wahounou *et al.,* 2011)

3.2 Conduct of the investigation: From the lists of producers with their villages provided by the group management organisations, the choice of villages to be surveyed was made at random. Subsequently, a draw of the villages where rubber growers were present was carried

out. Thus, the selection of a village automatically led to that of a group of growers. The plantations of the rubber growers selected by the random sampling were then observed by the phytosanitary agents. The plantations covered in the survey were such that all clones and ages were included. In addition to the sampled plantations included by random sampling, 5 industrial plantations and 5 village plantations reported as disease affected, by the management organizations were also surveyed. This kind of survey is called a "snowball". Its purpose is to collect information on diseased plots not covered by the survey carried out by the plant protection agents. The observations were made in five places equidistant on the diagonal axes of the plots visited. At each site, 100 rubber trees (5 lines of 20 trees) were observed and the observations recorded, which makes 500 rubber trees per plantation. The different symptoms observed on the leaves were noted. Symptoms such as rounded necrotic lesions, vein necrosis giving a typical "fishbone" profile, and defoliation were identified as trees attacked by *C. cassiicola*.

Table 1: Sample Size by Geographical Area

Regions	Localities	Framing Structures	Number of plantations	Size of the sample
South-west	San-Pedro, Grand Bereby, Sassandra	EXAT, SOGB, SAPH	13 618	419
South	Anguédédou, Bingerville, Grand-Lahou, Dabou, Sikensi, Tiassale	TRCI, IDH, CCP, HEVETEC, SAPH	24 497	754
Midwest	Soubré, Gagnoa	SOGB, SAPH	8 389	258
East	Abengourou, Daoukro, M'bahaiakro	SAIC, SAPH, EXAT	8 688	268
South East	Aboisso, Bonoua, Tiapoum	SAPH,	12 994	401
West	Duekoué, Guiglo, Man	CHC, SAPH	9 760	300
Total			**77 946**	**2400**

3.3 Assessment of the incidence of Corynespora leaf fall disease: The incidence of CLFD was evaluated in the localities and regions surveyed by reporting the number of diseased plantations on the total number of plantations of the surveyed clone. They are translated by the following formula:

$$IM = \frac{n}{N} \times 100$$

IM = Incidence of the disease
n = number of plantations attacked
N = total number of plantations surveyed

3.4 Statistical analyses: A variance analysis (ANOVA) at 5% significance was performed using the Statistica version 7.1 software to assess prevalence rates of the disease in each rubber sector. In order to normalize the distribution and equalize the variances, all incidence rates of CLFD were subjected to arcsine transformation. The comparison between the averages was made by the Newman and Keuls Student test with a probability of 5%.

4 RESULTS

4.1 Incidence of the disease by region:

Corynespora leaf fall disease is present in the Rubber plantations of Côte d'Ivoire. The phytosanitary survey carried out made it possible to assess the incidence of the disease in each rubber zone. These rates have statistically varied from one area to another (Figure 2). Thus, five homogeneous groups were identified. The first group, consisting of the Southwest Zone, recorded the highest rate, with 22.07% of plantations affected by the disease. The second group, the South-east had an incidence rate of 15.47% followed by the third group, the Central-east with 10.69%. The fourth group consisted of the southern and eastern rubber zones with incidence rates of 8.10 and 8.60% respectively. The last group, particularly the West, recorded a zero-incidence rate, indicating an absence of CLFD.

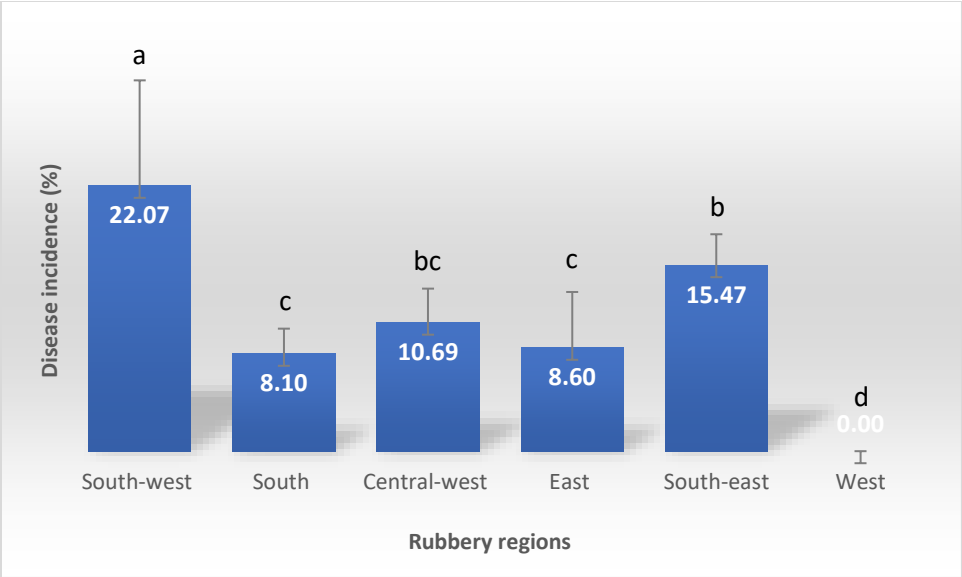

Figure 2: Incidence of Corynespora leaf fall disease in rubber growing regions

4.2 Incidence of the disease by locality:

Corynespora leaf fall disease was observed in all the localities surveyed except the localities in the West, notably (Bloléquin, Guiglo and Toulepleu) and the locality of Abengourou (East). The highest incidence rates were recorded in San Pedro and Sassandra with respectively 20.32 and 21.51%. The lowest incidences were observed in the localities of Daoukro and Gagnoa with rates of 5.40 and 5.64% respectively (Figure 3).

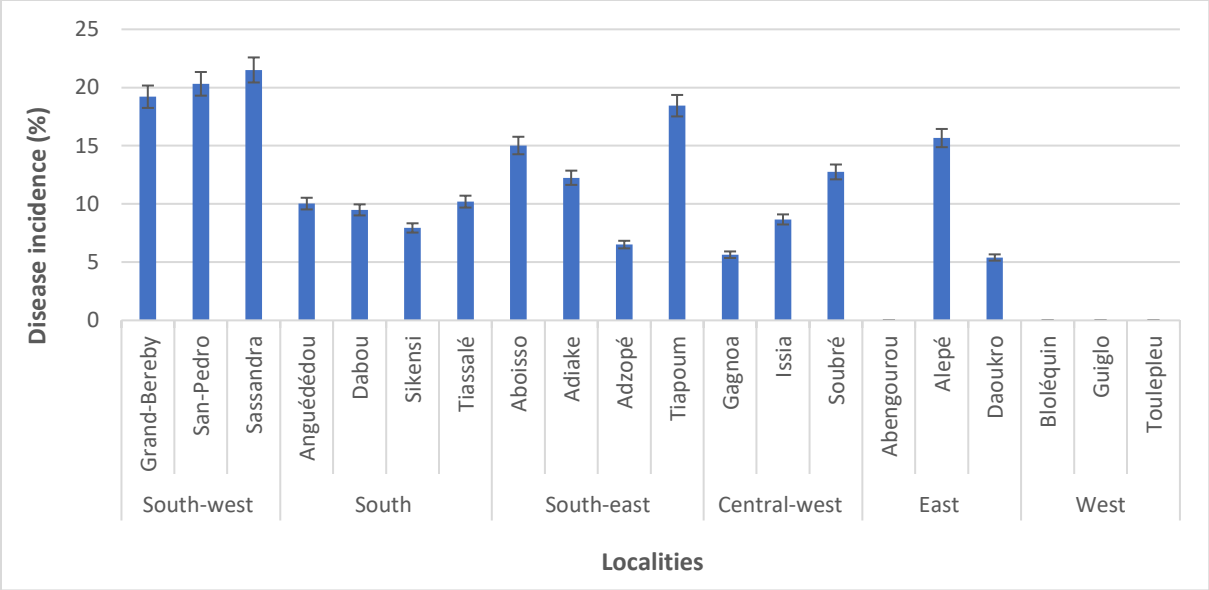

Figure 3: Incidence of Corynespora leaf fall disease by locality

4.3 Incidence of disease in the surveyed clones: The observations made in the rubber plantations also revealed the presence of CLFD on 3 clones, at different proportions (Figure 4). Thus, the clone IRCA 18 recorded the highest incidence rate with 74% of the plantations followed by polyclonal plantations with an estimated rate of 24%. The lowest incidence was observed on clone PB 260 (2%).

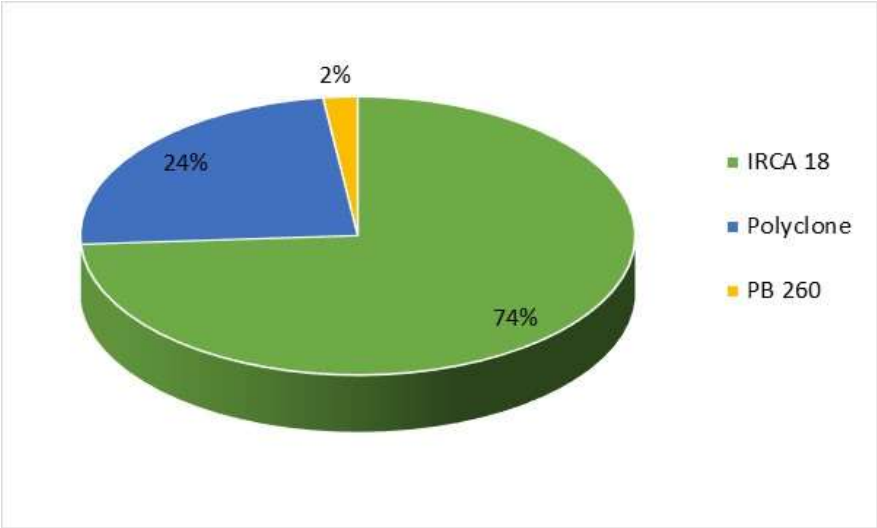

Figure 4: Proportion of clones affected by Corynespora leaf fall disease

4.4 Effect of age of clones on disease: The age of the clones had a direct effect on the incidence of CLFD (Figure 5). This study has shown that plantations with age between 21 and 30 years have recorded low attack rates of around 5%. On the other hand, young plantations, ranging in the age from 1 to 10 years, were the most affected, with a high CLFD incidence rate of around 72%. Plantations of age between 11 and 20 years recorded relatively moderate rates of disease incidence (23%).

Figure 5: Disease incidence by age of rubber plantations

5 DISCUSSION

The results of the survey revealed the presence of CLFD in five rubber-growing regions, notably the South, South-west, South-east, Center-west and East regions of Côte d'Ivoire. Only the western region (Guiglo, Soubré and Toulepleu) remained free from disease incidence. However, incidence rates varied considerably from one region to another. The highest incidences were observed in the South-west regions, specifically in the Sassandra and Southeast localities. The high incidence of CLFD observed in these regions could be attributed to the climatic conditions. In fact, these regions record high rainfall each year, which offers favourable conditions for the proliferation of spores of *C. cassiicola*. The, humidity generated by frequent rains in these areas would favour sporulation and germination of *C. cassiicola* spores. Similar observations have been made by Pawirosoemardjo *et al.*, (2009), reporting that an annual rainfall of over 2500 mm caused an outbreak of CLFD in West Kalimantan, Indonesia. In contrast to the South-west and South-east regions, the incidence of the disease appeared low in the South, Center-west and East regions and no incidence was reported from the western region of Côte d'Ivoire. The low incidence in these regions, except for the southern region, could be explained by the fact that these two regions belong to the new rubber growing zone where the pathogen pressure is low. To this could be added the fact that most farmers in these areas, having been sensitized to CLFD, would have used tolerant plant material to establish their plantations. Indeed, in addition to environmental conditions such as humidity and temperature, the susceptibility of clones would be a factor in the development of CLFD. Our work clearly shows that besides climatic factors (relative humidity, rain and temperature), the host (rubber clone) is also a determining factor in the epidemiology and distribution of the disease. This study revealed that in Côte d'Ivoire, clone IRCA 18 is the most affected with an estimated CLFD incidence rate of 74%. Similar observations were also made by Wahounou *et al.*, (2011) who reported during a phytosanitary survey, the presence of an outbreak of CLFD in Côte d'Ivoire, especially on the clone IRCA 18. As this clone was planted widely, it occupies about 10% of the rubber planted area in Côte d'Ivoire. The results of the investigations show that clone IRCA 18 is a potential source of inoculum of CLFD in Côte d'Ivoire and thus confirms that it is a major factor in the outbreak of this disease. The results also indicated that clone PB 260 and polyclonal plantations were attacked by this leaf disease, but

at relatively low levels. The incidence of CLFD in PB 260 populations remains minor (2%) which would indicate the tolerance of this clone to the disease. Breton *et al*., (1997) confirmed in a study the low susceptibility of the clone PB 260 to *C. cassiicola*. However, a clone having resistance to a pathogen can become susceptible over time. Suwarto *et al*., (1996) showed in a study of the susceptibility of rubber clones to *C. cassiicola* that clones GT 1 and RRIM 600 previously known to be resistant to CLF became susceptible following the development of new races of *C. cassiicola*. The age of the rubber tree is also important in the development of the disease (Mushrif *et al.,* 2020). The survey showed a high CLFD incidence of around 72% in plantations between 1 and 10 years of age. While in plantations with age over 20 years low incidence rates were observed (5%). The susceptibility of young plants to CLFD may be related to the absence of certain natural barriers against the disease that may develop during plant growth (Rappilly, 1991).

6. CONCLUSION

A survey of the Ivorian rubber plantations revealed the presence of leaf-fall disease caused by *C. cassiicola* in five regions, particularly the South-West (San Pedro, Grand Bereby), South (Anguededou, Agboville, Bingerville, Grand-Lahou, Dabou, Sikensi, Tiassalé, Adzopé), Central-West (Soubré, Gagnoa), Central-East (Abengourou, Daoukro, M'bahaiakro, Prikro) and South-East (Aboisso, Bonoua, Maféré). However, no CLFD incidence was recorded in western Côte d'Ivoire. Among the clones of rubber surveyed, IRCA 18 was the most affected with disease incidence rates of 74%, followed by polyclonal plantations (24%) and clone PB 260 (2%). In addition, a high incidence of CLF was noted in young plantations (72%) compared to older plantations (5%).

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