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Epidemiological State of Cassava Brown Streak Disease in North Kivu Province of the Democratic Republic of Congo

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ABSTRACT

Researches on Cassava Brown Streak Disease (CBSD) were conducted in North Kivu province. The study aimed to determine incidence and severity of cassava brown streak disease, evaluate whitefly abundance and infection origin. Incidence was evaluated using the proportion of damaged cassava plants by the disease and the severity was determined on leaves and stems using score ranging from 1 to 5. Whiteflies counting were done on the five first apical leaves. Infection origin was determined considering symptom appearence apical leaves (origin from whitefly) and on lower leaves (origin from infected cutting). Results show that cassava brown streak disease is in really present in north Kivu province with incidence reaching 26% and a severity of score 2 from the entire surveyed district. Incidence ranged from 2% with a severity of score 2 in Nyiragongo district up to 39% with a score of 2 in both Beni and Rutshuru district. Observed symptom proportions on stems were higher in Rutshuru (39%) but lower in Nyiragongo (2%). Whitefly population was high in Nyiragongo (37 whiteflies/cassava plant) but lower in Beni (5 whiteflies/cassava plant). Infection proportion due to whiteflies was of 1% in Rutshuru and 13 % in Masisi, while those from infected cutting as planting materials were of 4 % in Rutshuru and 47 % in Lubero.

1. Introduction

Cassava brown streak disease (CBSD) is a damaging disease caused by a virus which affects African cassava production and causing important losses of tuber and leaves (Legg *et al*., 2007 ; Mulimbi *et al*., 2012 ; Mahungu *et al*., 2014). CBSD produces brown necrosis in pulp and constriction in cassava tuber (Storey, 1936; Bakelana *et al*., 2018), which make tuber un edible(Hillocks *et al*., 2017). Brown streak are observed on stems (Figure 5). Moreover, necrotic cutting from diseased fields cannot be used as planting materials in a new field (CIRAD GRET, 2013). Cassava brown streak is a disease caused by two differents virus named *Cassava Brown Streak Virus* (CBSV) and *Ugandan Cassava Brown Streak Virus* (UCBSV) of (+) ssRNA belonging to genus of *Ipomovirus*, and family of *Potyviridae* (Mbanzibwa *et al*., 2009 ; Winter *et al*., 2010). It is mosty observed in Eastern region of cassava production of Est Africa and propagate toward central Africa (Legg *et al*., 2011). CBSD spread is from uses of cutting on infected cassava plants (Thresh *et al*., 1994). Spreading from a plant to another is done by whitefly (*Bemisia tabaci*, *Gennadius*, *Aleyrodidae*) (Maruthi *et al*., 2005).

North Kivu province in eastern Democratic Republic of The Congo share border with African Great Lake countries where report confirmed CBSD occurence (Alicai *et al*., 2007 ; Bigirimana *et al*., 2011 ; Adams *et al*., 2012 ; Mulimbi *et al*., 2012 ; Casinga *et al*., 2018). Worring were raised on CBSD spreading in the region from uncontrolled cutting movement accros border (Mulenga *et al*., 2018). In regard to CBSD in East of the Congo, Democratic Republic Mulimbi *et al*. (2012) reported for the first time its occurrence from sample collected only in the Lubero district of North Kivu province. The study aimed to clarify epidemiological state of CBSD from five districts of North Kivu by determining incidence, severity, whitefly population and infection origin from cassava fields.

2. Matériel and Methods

2.1 Study area

The study was done from 2016 to 2017 in North Kivu province located between 0° 58' latitude North and longitude between 27° 14' West and 29° 58' East. North Kivu is located atvan elevation between 800m and 2500m (http://rdcmaps.centerblog.net/20-la-province-du-nord-kivu). Investigation were done in five districts named Beni, Lubero, Masisi, Rutshuru and Nyiragongo (Figure 1).

2.2 Methods

Geo referenced investigation were conducted in farmers cassava fields. Cassava fields were of nine months old and more, distance between fields were of 10 km from the first up to the second fields for CBSD a long principal roads axis in North Kivu province. Sheets for cassava diseases surveillance from IITA were used. In total, 46 fields (Masisi 7 fields, Rutshuru 5fields, Beni 15fields, Lubero 15fields, Nyiragongo 4fields) were investigated in order to determine cassava

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brown streak symptoms at leaves and stems level. Investigation were done on thirty cassava plants sampled a long diagonal following x shape within each field (Osogo et al., 2014). Infection origin was determined considering symptoms on apical leaves (origin from whiteflies) and on lower leaves (origin from infected cuttings). Phytosanitary parameters data collection (incidence and severity) were done in the same time with whiteflies counting on the five first apical leaves on each plant. Whiteflies population density per plant corresponded to their average on thirty plants from field (Ariyo et al., 2005).

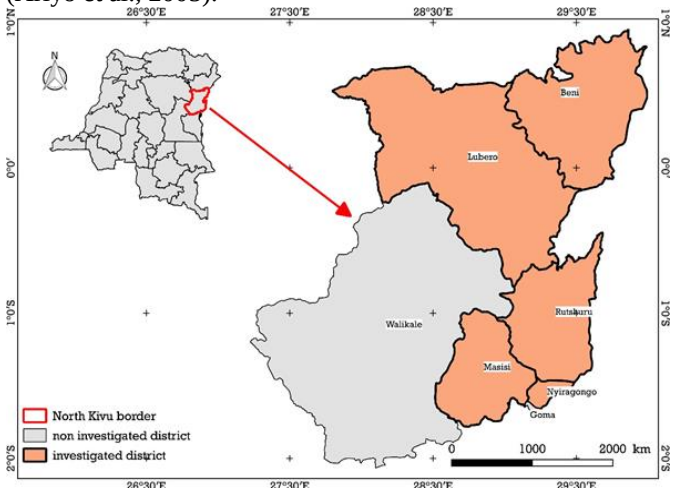

Figure 1. Map of North Kivu in East of The Democratic Republic of Congo showing study area

Leaves incidence was determined by the following proportion.

$$Incidence(\%) = \frac{Number\ of\ plants\ showing\ disease\ symptoms}{Total\ number\ of\ observed\ plants}\ X\ 100$$

CBSD severity was evaluated using evaluating scale from IITA ranging from 1 up to 5 (Gondwe et al., 2003 ; Alicai et al., 2016).

- Level 1: No apparent symptom on leaves,
- Level 2: Occurrence of light symptômes on leaves, no heavy symptoms on stems,
- Level 3: Occurrence of chlorotic leaves and slight lesion symptoms on stem, no die-back ;
- Level 4: Occurrence of chlorotic leaves and pronounced lesion symptoms on stem, no die-back ;
- Level 5: Occurrence of defoliation with lesions on stem and pronounced die-back.

Collected were analyzed using R package version 3.5.3. Cartographic record for illustration were processed using QGIS package version 3.4.

3. Results

3.1 Cassava brown streak pandemic characteristics in North Kivu province

Results of incidence and severity of CBSD in different cassava fields of North Kivu are presented on Figure 2.

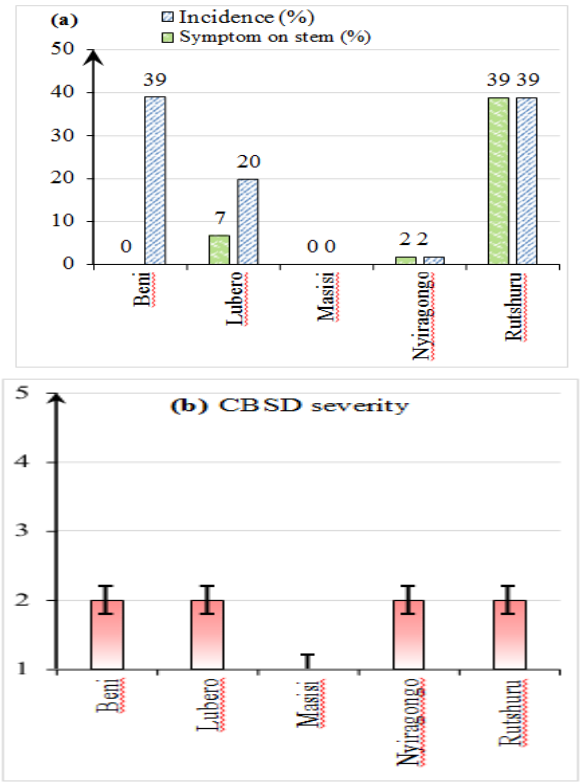

Figure 2. CBSD incidence (a) and Severity (b) in different districts of North Kivu

Figure 2 show that high incidence on leaves were determined in Beni and in Rutshuru (39%) with a severity reaching level 2 followed by Lubero (20%) with same severity of level 2. Low incidence level was determined in Nyiragongo (2%) but with severity of level 2. No CBSD symptom was observed in Masisi district. Incidence on stem were high in Rutshuru (39%) followed by Lubero (7%) and Nyiragongo (2%). IN Beni and Masisi district no smptom was observed on cassava stem.

3.2 Whiteflies Aboundance in North Kivu province

Evaluated whiteflies population density from cassava fields in investigated districts are illustrated on Figure 3.

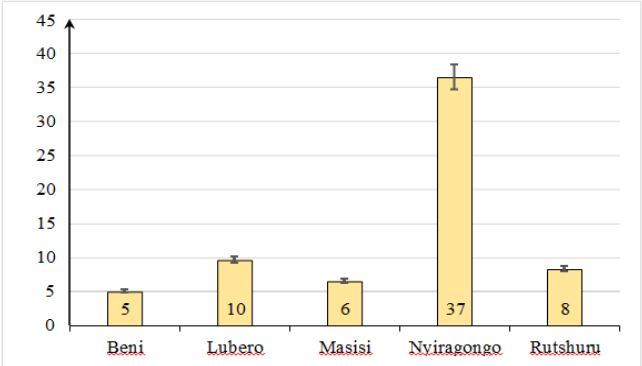

Figure 3. Whiteflies population density in North Kivu province

Figure 3 show high whitefly population density in Nyiragongo (37 whiteflies/cassava plant), followed by Lubero (10 whiteflies/cassava plant), Rutshuru (8 whiteflies/cassava plant) and Masisi (6 whiteflies/cassava plant). The lowest whitefly population density was determined in Beni (5 whiteflies/cassava plant).

3.3 Origin of disease infection

Results relative to CBSD infection origin in North Kivu province are presented in Figure 4.

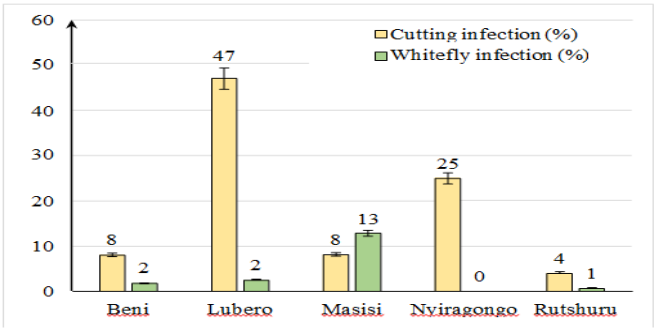

Figure 4. Map of CBSD infection origin in North Kivu province

Figure 4 show that infection caused by cutting is increasing in Lubero (47%) and in both Nyiragongo and Masisi (25%), Beni (8%) and Rutshuru (4%). Infection due to whitefly was highly important in Masisi (13%) but less important in Beni and Lubero (2%) and in Rutshuru (1%). Nyiragongo did not show any infection due to whitefly. By observing results, one can understand that the use of infected cassava cutting for planting is a major factor of spreading CBSD in North Kivu province.

4. Discussion

In DR Congo in general and specially in North Kivu province, cassava cultivation deserves special attention in the face of the Cassava brown streak disease which is one of the most devastating emerging virus disease.

However, an average incidence of Cassava brown streak disease observed for the whole of North Kivu is 26% with a severity of score 2. The observed numerical differences in incidence between the surveyed areas were not statistically significant (Kruskal-Wallis chi-squared = 6,9093 ; dl = 3 ; p-value = 0,07485). The same applies to the severity values recorded in the different districts (Kruskal-Wallis chi squared = 8,1637 ; dl = 4 ; p-value = 0,08576).

Our results are not similar to those found by Masinde et al (2016) and Mware et al (2009) in western and eastern Kenya where recorded CBSD incidences were typically high (5-74%; 38-93% respectively) but are similar to observations reported in east-central Uganda (4-64%) by Alicai et al. (2007). The severity varied considerably between districts and was higher in Rutshuru, Beni, Lubero and Nyiragongo with Severity score 2 and lower in Masisi with severity score 1. The high severity may be due to the virulence of virus strain circulating in the epidemic region or to the phenomenon of viral co-infection (Owor et al., 2004). Repeated planting cutting of contaminated plant material would thus increase the viral load in cassava plants with the consequence of worsening symptoms on the leaves.

The study suggests that transmission of CBSV is favoured by infected cuttings due to lack of control and availability of healthy planting material in Lubero and Nyiragongo, compared to Beni, Rutshuru and Masisi where healthy cuttings are disseminated by humanitarian organizations. These observations reinforce those of Monde (2010) who found that the use of previously infected virus cuttings concentrates a high inoculum potential in the farm, which contributes to the spread of viruses under high epidemic pressure.

The infection caused by cuttings shows statistically significant differences between districts (Kruskal-Wallis chi-squared = 14,236; dl = 3, p-value = 0, .0026), it is more widespread in Lubero (47%) and Nyiragongo (25%) than in Masisi and Beni (8%) and in Rutshuru (4%). Although it is relatively higher in Masisi (13%), statistical analysis of our data indicates non-significant differences in whitefly infection between districts (Kruskal-Wallis chi- squared = 5.8065; dl = 3; p-value = 0.1214).

It appears from the study that the whitefly density for all study areas was 13 whiteflies/plant. The highest white fly density was found in the Nyiragongo district with 37 whiteflies/plant, followed by Lubero with 10 whiteflies/plant, Rutshuru with 8 whiteflies/plant and Masisi with 6 whiteflies/plant, and finally Beni district with 5 whiteflies /plant. The difference in whitefly populations per district was statistically significant (P<0.05).

It is noted that the relatively high incidence of CBSD in the whole districts of North Kivu (26%) depends on the high abundance of whiteflies (13 whiteflies/cassava plant) (R= 0.12; S = 14324; p-value = 0.4403). Similar results were obtained by Mware et al. (2009) in Kenya where the high whitefly population (6.8 fly/plant) in Bondo Distr ict was positively correlated with a high CBSD frequency (100%). A low whitefly population (1 fly/plant) was re corded in Kirinyaga District in Kenya where CBSD was absent.

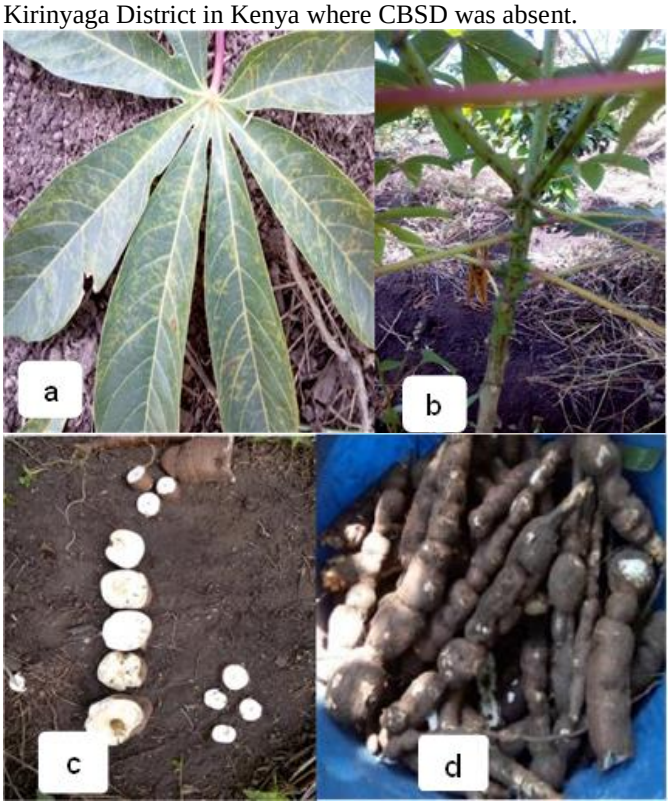

Figure 5: Symptoms of CBSD on leaves (a), stems (b) and tuberous roots (c and d). (Photo Yasenge).

5. Conclusion

Cassava brown streak is a very devastating disease causing huge yield losses. Results prove that the cassava crop in North Kivu province is exposed to the CBSD epidemy (Incidence 26%, severity 2, white fly density 13/plant). The main source of infection by the virus is diseased cuttings at an average of 18%. As cassava is a staple food and a source of income in North Kivu, the means to control CBSD must be put in place to stop its spread. This study recommends the use of CBSD resistant cultivars, the selection of asymptomatic cuttings for planting, and the production of healthy planting materials for dissemination and adoption.

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