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Research Paper

Diagnosis of cassava pathologies (Manihot esculenta crantz) in the Agroecological Region of Bengamisa, DR Congo.

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SUMMARY
The objective of this study is to make a diagnosis on the phytosanitary situation of cassava cultivation in the Bengamisa region. To this end, 56 fields located in fallow land, 45 in secondary forest and 24 in primary forest were sampled. The fields were three to six months old and averaged areas of 0.5 ha or more. At the end of the investigations, it was revealed that:
- In fallow land, the dominant pathologies are, in decreasing order, anthracnose, African cassava mosaic, brown spot disease, angular spot disease, Sigatoka and finally bacteriosis.
- In secondary forest, we have anthracnose, brown spot disease, mosaic of angular spots, Sigatoka and bacteriosis.
- In primary forest, plants are affected by anthracnose, brown spot disease, African cassava mosaic, angular spot disease, Sigatoka and bacteriosis.
Finally, the area is affected by several pathologies which requires further specific studies.

Keywords: Diagnosis – pathologies – cassava

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I. INTRODUCTION

Cassava (Manihot esculenta crantz) is one of the most widely grown crops in sub-Saharan Africa. Its total production of over 177 million tons is higher than that of any other crop in Africa (Faostat, 2017, Kadima, U. et al., 2016). The average cassava yield in Africa is estimated at 8.98/ha (Legg et al., 2021).

In DR Congo, the total production of cassava exceeds 31 million tons and amounted to 31,596,046 tons (Faostat, 2017). The average yields obtained in peasant agriculture vary between 5 to 8 tonnes/ha (Muhindo., 2020, Bakelana., 2019, Bakelana, and al., 2018, Mahungu, and al., 2014). This low yield in Africa is attributed to diseases and pests (Faostat, 2017, Monde., 2010, Oerke and Dehne., 2004 and Thèbérge et al., 1985,). In the agro-ecological region of Bengamisa in Banalia Territory (DR Congo), cassava cultivation is an activity that contributes to the availability of food and financial means in agricultural households, the threats facing the culture require a particular attention. However, data on cassava pathologies in the region are not documented due to lack of specific studies. It is therefore interesting to carry out a diagnosis on the most recurrent cassava diseases in order to properly combat or prevent them; also to identify the risk factors that can lead to control mechanisms adapted to local conditions.

2.2. MATERIAL AND METHODS

This study is conducted in the region of Bengamisa, in Banalia Territory, Tshopo Province.
The plant material used consists of cassava cultivars grown in the area.

- Data collection and sampling

Disease inventories are conducted in 10 villages located in the sectors. Bamanga/Bengamisa and Boumbwa, Territory of Banalia, Province of Tshopo. We proceeded by reviewing the literature and the phytosanitary survey in the targeted villages. The observation method is used to determine the diseases encountered and for this the identification of photographs is used (Autrique and Parreaux, 1989).

The diagnosis was carried out on fields aged 3 to 6 months. They concern three (3) strata including fallow land, secondary forests and primary forests. Fields taken as samples have a minimum area of 0.5 ha. They are made diagonally for each field and consist in observing the presence of the diseases on all the plants which are on the diagonal (Metrick., 1996).

We sampled 125 fields including 56 fallow, 45 in secondary forest and 24 in primary forest, about 15 feet/field were invested; which makes a total of 1875 feet. The study system includes two types of variables. The explanatory variables are the density, the variety, the age of the crop, the type of landscape, the surrounding vegetation, the origin of propagation material, the type of agriculture, the practice of leaf picking, the period of cuttings, the method of cuttings, the clonal diversity in the field. The explained variables or responses: Incidence and severity of the different diseases.

The method of macroscopic observation using boards and scales was used to identify diseases. The diagnosis is made on the basis of the incidence of diseases of the plants sampled according to the strata.
The leaves and stems of the plants will be observed.
Statistical analysis
The impact will be determined using the following formula:
1.Diagnusis of cassava pathologies in the Agroecological region of Bengamisa.

$$\text{Incidence}(\%) = \frac{\text{Total of diseased plants}}{\text{Total number of sample plants}} \times 100$$

2.Indence of severity or seriousness of cassava pathologies in the agroecological zone of Bengamisa , territory of Banalia, DR Congo.

II. Results

Tables (1), (2) and (3) respectively illustrate the frequency of pathologies according to the forest stratum (fallow, secondary forest, primary forest).
The observations related to 1875 feet distributed according to three strata of forest with the following proportions: 840 (fallow), 675 (secondary forest) and 360 (primary forest).

Table I: Diagnosis of fallow pathologies

Diseases	Total feet	Fréquency	%
Mosaic	840	699	83,21
bacteriosis	840	191	22,74
Angular spot diseases	840	523	62,26
Anthracnose	840	701	83,45
Brown stains	840	583	69,4
Sigatoka	840	392	46,67

The inventory of cassava diseases in stratum (1): Fallow led to the identification of (6) diseases including mosaic (83.21%), anthracnose (83.45%), brown spot disease (69.4%), angular spot disease (62.26%), Sigatoka (46.66%) and bacteriosis (22.74%).

This situation is due to the fact that in fallow, farmers exploit a combination of improved cultivars and those said to be local. The topping of the leaves is too important, which promotes the spread of cassava mosaic and other diseases such as bacteriosis, etc. Anthracnose, on the other hand, seems to have a high score after the mosaic, its presence is due to the fact that the cuttings are distributed throughout the village. Some improved or resistant varieties have become vulnerable, due to certain practices relating to the shortening of the fallow period, impoverishing the soil and not allowing good crop growth.

Table II: Diagnosis of pathologies in secondary forest

Diseases	Total feet	Fréquency	%
Mosaic	675	485	71,85
bacteriosis	675	10	5,78
Angular spot diseases	675	423	62,67
Anthracnose	675	523	77,48
Brown stains	675	493	73,04

Sigatoka	675	195	28,89

The inventory of diseases in stratum (2): secondary forest revealed the presence of the following diseases according to the following proportions: Anthracnose (77.48%), brown spots (73.04%), cassava mosaic (71.8%), angular spot disease (62.67%), circosporiosis (28.87%) and bacteriosis (5.78%).

This situation is linked to the fact that in secondary forest, far from the village, leaf topping is less frequent, but on the contrary the fields are covered with weeds.

Anthracnose colonizes a large proportion of the plants in the sample; its presence is favored by humidity, freshness, brown and white spots also have a strong impact due to humidity. As the African cassava mosaic virus recedes to this forest stratum, the frequency of weak leaf topping prevents mechanical transfer or transmission of the virus from one plant to another. Bacteriosis, on the other hand, is limited because as the fields move away, the use of tolerant or resistant varieties is reduced.

Table III: Diagnosis of pathologies in primary forest

Diseases		Total feet	Frequency	%
1	Mosaic	360	248	68,89
2	bacteriosis	360	10	2,78
3	Angular spot diseases	360	219	60,83
4	Anthracnose	360	303	84,2
5	Brown stains	360	279	77,5
6	Sigatoka	360	103	45,3

In stratum (3): primary forest, observations showed that African cassava mosaic is present in 68.81% of the sample, anthracnose (84.2%), brown spot disease (77, 5%), the disease angular spots (49.72%) and the symptoms of bacteriosis (2.78%).

This situation is due to the fact that in primary forest, the varieties exploited are essentially local. They are prey to all kinds of diseases, although the incidence of mosaic is low, this is due to the reduction of cultural practices favoring the mechanical transmission of the virus. On the other hand, fungal diseases (anthracnose, spotting, Cercosporiosis) become more widespread as a result of increased humidity conditions. These conditions, on the other hand, limit the harmful effects of bacteriosis.

III. Discussion

Cassava is the main food product in the D.R. Congo. Cultivation extends over the entire territory in general, in particular in the Territory of Banalia, Province of Tshopo and makes it possible to feed or meet the food needs of the population and also provides a significant income. However, this culture solution for the country deserves special attention, and especially protection against diseases that pose a permanent threat to its expansion. The crop is attacked by several diseases at once, which makes it weak and less productive. At different levels, each of these diseases constitutes significant economic losses, although in general mosaic poses the main threat.

Thus, the incidence of diseases varies according to forest strata (fallow, secondary forest and primary forest). Some evolved in incidences and others retrograded. For the first according to strata, Anthracnose, brown spot disease and angular spots, which are fungal diseases. For others, the incidence decreases according to the landscape; these are African cassava mosaic, bacteriosis and Sigatoka.

The overall disease incidence ranged from 5.29% to 84.2%. This situation is due to the use of infected cuttings and low use of disease-tolerant or disease-resistant cuttings. This incidence was influenced by certain conditions or risk factors including the local climate, cultural practices, soil or level of soil fertility.

For the most common diseases in DR Congo, we find that:

- Symptoms of anthracnose have been reported in fields located in the (3) strata, they are widespread in primary forest than in secondary and fallow forest;
- Bacteriosis is not widespread, it is rare in primary forest, although slightly visible in fallow land; this is justified by the use by some farmers of improved cultivars;
- Leaf spots (diseases of angular spots, those of brown spots) are present in all strata and their evolution is centrifugal;
- Sigatoka was reported in all strata, but with a low incidence;
- The African cassava mosaic is present in all strata; but its incidence follows a centripetal evolution. The threshold reached by mosaic is 83.21% lower than that obtained in the Central African Republic (84.95%).

Indeed, Mupenda and Walangululu (2016) were able to show in their study conducted in rural areas of South Kivu, on the western coast of Lake Kivu, that among the diseases causing significant losses in cassava yield, there is first of all the mosaic African cassava which has a higher incidence and severity than other diseases,

anthracnose has, on the other hand, a low incidence as well as leaf spotting. This is explained by the low use of resistant exotic cuttings as well as the forest use of infected cuttings.
Moreover, Litucha (2011) showed that there is a direct effect of leaf picking on the level of secondary infection of the crop. By the African cassava mosaic. Indeed, in our study environment, cassava leaves are the staple food of local populations and a source of income. Leaf picking frequency is high; which leads to the rapid spread of diseases by contact. A point of view also shared by Fargette et al. (1986) demonstrating that the use of infected cuttings, especially of weakly resistant varieties, as well as the frequency of leaf picking constitute ways of perpetuating the African cassava mosaic.
Finally, Plan Genest et al. (2007) highlighted the role of landscape characteristics on the epidemiology of diseases and their dynamics. For these authors, there is an influence of landscape factors on the distribution of diseases, their incidence and their severity.
On this subject, our surveys have shown that in the landscapes under study (fallow land, secondary and primary forest), the distribution of diseases is variable, sometimes it increases (Anthracnose, etc.), sometimes it decreases (African mosaic cassava, …). Sometimes it is stable.

IV. Conclusion

The surveys were carried out in the Province of Tshopo, precisely in the Territory of Banalia. The groups concerned by this study were: Abata, Bamanga – Bengamisa, Boumbwa, Bamanga/Bangelema and Bangelema where cassava is grown on a large scale. We proceeded by the bibliographic analysis and the phytosanitary survey preceded by a pre-survey and according to the diagonal technique. This survey was carried out according to the strata of forest including fallow (1), secondary forest (2) and primary forest (3) in order to assess the variability of pathologies.
It appears from these results that:
- In fallow, anthracnose and African cassava mosaic are more important, followed by leaf spots (diseases of angular spots and brown spots, then Sigatoka and bacteriosis in much lower proportions;
- In secondary forest, anthracnose still in the lead, followed by brown spot disease, African cassava mosaic, angular spot disease, Cercosporiosis and bacteriosis in small proportions compared to the fallow;
- In primary forest, cryptogamic diseases dominate (Anthracnose, leaf spots: angular spots and brown spots), then African cassava mosaic, anthracnose and bacteriosis in even smaller proportions.
These results show that the landscape has played an influence on the behavior of certain diseases as well as their dynamics, in particular anthracnose and leaf spots (brown and angular spots) which are of cryptogamic origin, the humidity of the forest allows them to spread at high speed.
On the other hand, the mosaic is seen in decline because of the low frequency of leaves for survival needs due to the distance from the fields. Bacteriosis and Cercosporiosis are rare in local varieties, they have been imported by tolerant varieties, as these are grown more in fallow land, their expansion in primary and secondary forest is low.

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