

**Original Research Article**

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**Occurrence of Cassava Mosaic Disease Related to Agro-ecosystem in  
Farmer's Fields located in Kongo Central Province, Democratic Republic of  
Congo**

## 7 ABSTRACT

8 **Aim:** To assess the Cassava Mosaic Disease (CMD) pressure by analyzing its incidence,  
9 severity and gravity, and to characterize agro-ecosystems where cassava farmers' fields are  
10 established.

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12 **Place and duration:** The study was conducted in three different localities (Mvuazi, Ndembo  
13 and Pompage) in Kongo Central province, Democratic Republic of Congo, from June to  
14 December 2016.

15 **Methodology:** One hundred and fifty farmers' fields randomly selected were investigated  
16 during epidemiological survey, with 50 fields in each locality. In each field selected, 30  
17 cassava plants randomly selected in a square of 10m x 10m were analyzed. The CMD  
18 incidence, severity and gravity were collected, and agronomic and environmental factors  
19 relative to cassava fields were analyzed.

20  
21 **Results:** In general, CMD was observed in the three localities, with pressure depending  
22 upon to localities and fields. The distance between two neighboring fields could vary from 5  
23 to 35 or even 50m. Pathological parameters show significant difference ( $P = .05$ ) among  
24 fields for the same locality. The lowest pressure was recorded in Mvuazi locality (with 12.8%  
25 for incidence, score 2 for severity, and 15% for gravity), while the highest pressure was  
26 recorded in Pompage (with 20% for incidence, score 3 for severity, and 32% for gravity).  
27 Data recorded on agro-environmental factors show that farmers of the three localities used  
28 almost the same agricultural practices. Analysis of data reported suggest that the origin and  
29 the type of cassava material cuttings used can play a principal role in the propagation and  
30 development of CMD in most of cassava cultivation regions.

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32 **Conclusion:** The results of the present study revealed that CMD was present in different  
33 localities surveyed, and its pressure varies among localities, and from one field to another for  
34 the same locality. Agricultural practices used by farmers can play an important role in the  
35 propagation of CMD in different regions of cassava cultivation.

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39 **Keywords:** *Cassava Mosaic Disease, Farmers' fields, Agro-Ecosystem, Kongo Central*  
40 *province, DR-Congo.*

## 41 1. Introduction

42

43 Cassava (*Manihot esculenta* Crantz) is an important source of calories for thousands of people living  
44 in sub-Saharan Africa [1, 2]. Plant with high potential and adapting to different environments [3],  
45 cassava is however subject to the attacks of Cassava Mosaic Disease (CMD) which constitutes a  
46 serious and persistent threat to the food security of populations mainly living of that food.

47

48 In Africa, various works of selection and improvement of cassava led to the development of varieties  
49 containing acceptable agronomic and qualitative characteristics, and resistant to diseases such as  
50 CMD and Cassava Bacterial Blight (CBB) [4, 5]. These varieties have often been introduced and  
51 distributed in many regions to control the CMD pandemic. Despite these breeding, improvement and  
52 extension efforts, it was observed that the CMD continues to spread with high incidence and severity  
53 levels. One of causes that would be the basis for the CMD perpetuation in these regions is the low  
54 adoption of improved varieties by farmers. Indeed, farmers felt that these varieties did not meet their  
55 expectations and preferences [6, 7], which results in the widespread use of local varieties.

56

57 In the Democratic Republic of Congo (DRC), studies conducted on the evaluation of the CMD  
58 pressure indicate that the cassava germplasm is susceptible to this viral disease. For examples, in  
59 Yangambi region (Eastern province), Monde [8] found that the majority of local varieties showed  
60 severe symptoms of the disease, compared with improved varieties. In Bukavu region (Sud Kivu  
61 province), Bisimwa [9] noted that local cassava varieties grown in different agro-ecosystems were all  
62 susceptible to various biotic diseases identified on cassava. In Gandajika (Eastern Kasai province),  
63 Muengula-Manyi *et al.* [10] observed that local varieties grown by farmers are severely attacked by  
64 CMD compared to improved varieties.

65

66 Various other scientific studies have shown that local cassava varieties are severely attacked than  
67 improved varieties. Jeremiah & Kulembeka [11] mentioned that all local cassava varieties available  
68 are susceptible to CMD. In many countries, CMD would have reached a high severity degree on  
69 farmers' fields, which may reduce the yield of cassava tuberous roots. The level of CMD infection  
70 varying from agro-ecological systems [12], and poor farming practices and marginal agro-  
71 environmental conditions observed in farmers' fields are favorable for CMD development.

72

73 This study aimed to assess the CMD pressure by analyzing the disease incidence, severity and  
74 gravity in Mvuazi, Ndembo and Pompage localities (in the Kongo Central province), and to  
75 characterize agro-environmental factors where cassava farmers' fields are established.

76

## 77 **2. Materials and Methods**

### 78 **2.1. Sites Description and Field Sampling**

79

80 Epidemiological surveys were conducted in Mvuazi, **Ndembo** and Pompage localities (Kongo Central  
81 province) in DRC. These regions fall within the Aw4 climate type according to Köppen classification  
82 characterized **by** 4 months of dry season coupled 8 months of rainy season. Daily temperature  
83 averages 22-24°C and can reach a maximum of 30°C. The average annual rainfall ranges around  
84 1,522mm. The surveyed sites were characterized by the presence of savannah dominated by  
85 herbaceous species such *Hyparrhenia diplandra*, *Mucuna* sp., *Panicum maximum* and *Pennisetum*  
86 *purpureum*. In some places, it **is** observed ragged forest where dominated shrub species such **as**  
87 *Lussonia angolensis* and *Hymenocardia acida*. According to Pauwels [13], soils of Kongo Central  
88 region are varying types, and revealed the presence of sandy and clay soils.

89

90 Epidemiological surveys were conducted in cassava farmers' fields during the period from June to  
91 December 2016. In each locality, 50 fields randomly selected were investigated. In each field  
92 selected, 30 cassava plants randomly selected in a square of 10m x 10m were analyzed.

93

### 94 **2.2. Variables Studied**

#### 95 **2.2.1. Pathological Variables**

96

97 During epidemiological investigations, pathological variables recorded were CMD incidence, severity  
98 and gravity. The CMD incidence was **assessed** by the proportion of diseased plants compared to 30  
99 plants analyzed. CMD severity symptom was assessed using a scale ranging from 1 to 5 described  
100 by Hahn *et al.* [14], where 1 represents an asymptomatic cassava plant (apparently healthy) and 5 a  
101 severely infected cassava plant with reduction of leaflets. The CMD gravity was assessed in each  
102 diseased plant by the proportion of leaves with typical symptoms of the disease.

103

#### 104 **2.2.2. Agronomic and Environmental Factors**

105

106 For each field surveyed, agronomic and environmental characteristics as described by Muengula-  
107 Manyi *et al.* [10] were determined. They include field location, origin and type of cassava material  
108 used, age of fields, topography of land, the practice of intercropping, type of crops mixed with  
109 cassava, and the topping practice.

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111

## 112 2.3. Data Analysis

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114 Statistical analysis of data recorded was made possible through the R software and Statistix 8.0 (free  
115 version). The recorded data were submitted to analysis of variance followed by multiple comparisons  
116 by Tukey's HSD, to determine significant differences ( $P = .05$ ) between the surveyed sites. CMD  
117 incidence and gravity were previously submitted to a logarithmic transformation to base 10 ( $\log_{10}$ ).  
118 The comparison of means was made using the least significant difference test (LSD) at the 5%  
119 probability.

120

## 121 3. Results

### 122 3.1. Incidence, Severity and Gravity of Cassava Mosaic Disease

123

124 Results obtained on CMD incidence, severity and gravity recorded in the 3 localities are reported in  
125 Table 1.

126

127 Table 1. Incidence, severity and gravity of CMD recorded in Mvuazi, Ndembo and Pompage locality

128

Locality	Pathological variables recorded		
	Incidence (%)	Severity (scale 1 - 5)	Gravity (%)
Mvuazi	12.8 <sup>b</sup>	2	15 <sup>c</sup>
Ndembo	15.2 <sup>b</sup>	3	25 <sup>b</sup>
Pompage	20 <sup>a</sup>	3	32 <sup>a</sup>

129 *In the same column, means followed by the same letter are not significantly different at 5% of*  
130 *probability.*

131

132 In general, CMD was present in all sites surveyed with levels of incidence, severity and gravity  
133 varying between localities, and from one field to **another** in the same locality. There were significant  
134 differences for disease incidence and gravity among fields for the three sites (Table 1). Overall, the  
135 mean incidence for all fields surveyed was 16%, severity score was 2.6, and gravity equal to 24%.  
136 Details for each locality revealed that the incidence of CMD was 12.8% in Mvuazi, 15.2% in Ndembo  
137 and 20% in Pompage. The mean of CMD severity was equal to 2 in Mvuazi, and 3 in Ndembo and  
138 Pompage, and the gravity was respectively equal to 15, 25 and 32%.

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140

### 141 3.2. Agronomic and Environmental Characteristics of Fields Investigated

142

143 The results of different agronomic and environmental factors analyzed for each cassava field  
144 prospected in Mvuazi, Kimpese and Pompage localities are reported in Table 2.

145

146 Table 2. Frequency (%) of cassava fields characteristics in 3 localities investigated in Kongo Central  
147 region

Characteristics of fields	Localities		
	Mvuazi	Ndembo	Pompage
<b>Field location</b>			
Secondary forest	40	70	64
Savannah	60	30	36
<b>Site topography</b>			
Flat land	70	24	60
Land with slope	30	76	40
<b>Origin of cassava material used</b>			
Research center	90	-	-
Old field	10	100	100
<b>Type of cassava material used</b>			
Local	14	90	96
Improved	86	10	4
<b>Age of field</b>			
1 to 6 months	8	10	8
7 to 12 months	86	70	72
Older than 12 months	6	20	20
<b>Intercropping practice</b>			
Yes	15	90	85
No	85	10	15
<b>Crop mixed with cassava</b>			
Legume	15	35	45
Cereal	75	25	25
Vegetable crop	10	40	30
<b>Topping practice</b>			
Yes	66	68	70
No	34	32	30

148

### 149 3.2.1. Field location and site topography

150 Cassava fields investigated were established either in secondary forest or savannah. In the 3  
151 localities, cassava crop grown in secondary forest represented 58%, while those established in  
152 savannah represented 42%. Farmers' fields were established either on flat land or on land with slope.  
153 It was observed that 51.3% of cassava crops were grown on flat lands and 48.6% on lands with slope.  
154 Details of cassava fields location and site topography for each locality are described in Table 2.

155 **3.2.2. Origin and type of cassava material used**

156 Analysis of data reported in Table 2 revealed that 30% of farmers used cassava cuttings obtained  
 157 from a Research Center, and 70% used cuttings obtained from their previous fields. Farmers used  
 158 local or genetically improved cassava varieties. Local cassava varieties were grown in 66.6% of fields,  
 159 while improved varieties were planted in 33.3% of fields.

160 **3.2.3. Age of field**

161 According on the date of cassava plantation, fields investigated were classified in 3 groups. The first  
 162 group included 1 to 6 months old cassava field, the second group with 7 to 12 months, and the third  
 163 group with fields older than 12 months (Table 2). Results obtained revealed that 8.6% of cassava  
 164 fields were 1 to 6 months old, 76% were 7 to 12 months old, and 15.3% were older than 12 months.  
 165 Details of the three groups for each locality are described in Table 2.

166 **3.2.4. Intercropping practice and type of crops mixed with cassava**

167 The results of this study revealed that cassava was generally grown in association with other crops  
 168 such as legumes, cereal or vegetable crops. Analysis of these results indicated that 63.3% of cassava  
 169 were mixed with other crops, while in 36.6% of cases, cassava crop was grown alone. In general,  
 170 31.6% of cassava stands were grown in association with legumes (soybeans or beans), 41.6% with  
 171 cereal (principally maize) and 26.6% with vegetable crops (sweet potatoes). Frequency of  
 172 intercropping practice and crops mixed with cassava varied according to localities surveyed (Table 2).

173 **3.2.5. Topping practice**

174 It observed that field topping was generally practiced in the three localities surveyed. This suggest  
 175 that cassava leaves are appreciated such an edible legume to meet household needs. Field topping  
 176 was practiced in 68% of cassava stands, while no topping was reported in 32% of fields investigated.  
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178 **4. Discussion**

179

180 This study revealed the presence of cassava mosaic disease (CMD) in different cassava farmers'  
 181 fields located in Mvuazi, Ndembo and Pompage localities in Kongo Central province. Overall, CMD  
 182 pressure assessed by the analysis of incidence, severity and gravity generally varies among localities,  
 183 and from one field to another in the same locality.

184

185 The analysis of pathological variables reported in Table 1 revealed significant difference ( $P = .05$ )  
 186 among localities. In general the CMD pressure was low in Mvuazi, whereas it was higher in Pompage  
 187 locality. Results of this study show that CMD pressure is slightly lower compared to data presented in  
 188 previous studies. In other regions of DRC, Sseruwagi et al. [15] revealed that the mean incidence of  
 189 CMD during the period 2002-2003 was approximately 60%, with severity score equal to 3.1.  
 190 According to Ariyo et al. [16] and Ntawuruhunga et al. [17], usually the incidence and severity of CMD  
 191 vary according to the year, and from one region to another. Adjata et al. [18] mentioned that the level

192 of CMD incidence probably changes with the pressure of inoculum, which varies from one site to  
193 another. Based on our findings and those of previous studies, it is clear that pathological parameters  
194 (incidence, severity and gravity) fluctuate depending on several factors such as agronomic,  
195 environmental and **the pressure of inoculum** prevailing in a region, as well as time or period of  
196 observations. In addition, Sseruwagi et al. [15] mentioned that in some moderately resistant varieties,  
197 symptoms of CMD can be localized or absent in some parts of cassava plant. Muengula-Manyi et al.  
198 [10, 19] also observed on a diseased cassava plant that CMD symptoms did not necessarily  
199 appeared on all leaves present on the plant. These observations explain the variability of **level** of  
200 gravity recorded on the diseased plants surveyed.

201

202 Results reported in Table 2 indicate in general that farmers use almost the same agricultural practices  
203 in the cultivation of cassava. Based on characteristics of fields surveyed, it appeared that 90% of  
204 farmers located in Mvuazi use cuttings obtained from the Research center, while all farmers (100%)  
205 founded in Ndembo and Pompage localities use cuttings from their previous fields. In addition, in  
206 Mvuazi locality, 86% of cassava varieties planted are genetically improved, while 93% of cassava  
207 material used in Ndembo and Pompage localities are local varieties (Table 2). These observations  
208 may explain the low CMD pressure noted in Mvuazi compared to the two others localities. The results  
209 of this study corroborate findings reported by Bisimwa [9] who observed in Bukavu region, that  
210 cassava farmers' fields heavily attacked by biotic diseases were planted from local varieties.  
211 According to Hillocks & Thresh [20], in some regions the lack of improved varieties orient farmers  
212 towards large-scale use of local varieties; and the high frequency of use of local varieties could also  
213 be explained by the quest characteristics valued by farmers and by the cost of improved cassava  
214 varieties cuttings. In addition, the use of cuttings without health guarantee, taken from previous fields  
215 may explain the permanent presence of CMD in some cassava production regions.

216

217 Although the CMD was observed in the three localities, its incidence was overall lower compared to  
218 data reported by Sseruwagi et al. [15], while the severity score reported in these two studies was  
219 similar. The low level of CMD incidence reported in this study may be due to the use of intercropping  
220 practice and the type of crop mixed with cassava. Indeed, there was different crops intercropped with  
221 cassava in the three localities surveyed. For example, in Mvuazi, cassava was mixed with cereal in  
222 75% of fields investigated, while in Ndembo it was mixed with vegetable crop in 40%, and in  
223 Pompage with legumes in 45% (Table 2). Our results corroborate observations made by Monde [8]  
224 who observed in the Yangambi region, that incidence and severity of CMD were very lower in fields  
225 where cassava was mixed with beans compared to fields where cassava was cultivated without crop  
226 mixed.

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229



230 **5. Conclusion**

231

232 The results of the present study revealed that CMD occurs in the three localities surveyed, and its  
 233 level pressure varies between localities, and between different fields in the same locality. In general,  
 234 results obtained showed that farmers used almost the same agricultural practices to establish their  
 235 cassava fields. Origin and type of cassava material used **indeed** play a significant role in the spread  
 236 and development of CMD. In the region where improved varieties were used, CMD pressure **was**  
 237 **lower than where local varieties were used.** **The** low level of incidence, severity and gravity of CMD  
 238 can be attributed to the use of intercropping practice and the type of crop mixed with cassava.

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240 **References**

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