Sciences, Technologies et Développement, Volume 18, pp31- 39, Septembre 2016
http://www.univ-douala.com/std/
ISSN 1029 – 2225 - e - ISSN 2313 - 6278

Survey on the current diseases status of local versus improved cassava varieties and their management strategies in Cameroon

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Received: November 2015 Revised: August 2016 Accepted: August 2016 Available online: September 2016

Abstract
We conducted two main surveys in 29 sites within the five antennae of the Cameroon National Program for Roots and Tubers Development (PNDRT), to assess potential changes triggered by the introduction of improved varieties on cassava disease status. Standard methods were used to evaluate diseases incidences and damages severities on both local and improved varieties. Symptoms of six diseases were observed in cassava fields including cassava mosaic disease (CMD), cassava anthracnose disease (CAD); cassava bacterial blight (CBB), cassava root rot (CRR), cassava brown leaf spot and cassava white leaf spot. The incidence and severity of these diseases varied considerably between antennae, sites and cassava varieties. Their severities were generally mild to moderate. In general, local varieties were significantly more attacked by CMD and CBB than improved ones while CAD infested equally both varieties. In conclusion, the introduction of improved cassava varieties has significantly reduced the incidence and severity of CMD and CBB effect on cassava development and consequently on yield. Despite this achievement, CAD and root rot remain a problem for cassava production in Cameroon Collaborative effort should therefore continue to develop, select and introduce resistant material against major diseases.
ISSN 1029–2225c2016 Sciences, Technologies et Développement
Key words: *Cameroon; cassava; diseases management; improved varieties.*

Résumé
Nous avons mené deux enquêtes principales pendant deux saisons sèches dans 29 sites situés dans cinq antennes du Programme National de Développement des Racines et Tubercules (PNDRT) du Cameroun pour évaluer des changements potentiels de la situation des maladies induits par l'introduction des variétés améliorées de manioc. Des méthodes standards ont été utilisées pour évaluer l'incidence des maladies et la sévérité de leurs dégâts sur les variétés locales et améliorées. Les symptômes de six maladies ont été observés dans les champs à savoir la mosaïque du manioc, l'anthracnose du manioc, la bactériose du manioc, la pourriture racinaire du manioc, la maladie des taches brunes et la maladie des taches blanches du manioc. L'incidence et la sévérité des dégâts ont variés considérablement entre les antennes, les sites et les variétés de manioc. La sévérité des dégâts était généralement moyenne à modérée. Les variétés locales étaient significativement plus attaquées par la mosaïque et la bactériose que les variétés améliorées alors que l'anthracnose a attaqué également les deux types de variétés. En conclusion, l'introduction des variétés améliorées de manioc est entrain de réduire significativement l'incidence et la sévérité de la mosaïque et la bactériose sur le développement et par ricochet la production du manioc. Cependant, l'anthracnose et la pourriture racinaire restent toujours un problème pour la production du manioc au Cameroun. Ainsi, la collaboration doit continuer pour développer, sélectionner et introduire du matériel végétal résistant aux maladies majeures du manioc.
ISSN 1029–2225c2016 Sciences, Technologies et Développement
Mots clés: *Cameroun; manioc; gestion des maladies; variétés améliorées.*

1. Introduction

Introduced in Africa from Central and South America by Portuguese in the 16th century (Purseglove, 1982), cassava (Manihot esculenta Crantz) has spread throughout sub-Sahara Africa, and has become one of the dominant starchy staples food in the diet of the people. Cassava provides a basic daily source of dietary energy to the smallholder farmer and small income from processed products (CIAT, 1996; Nweke, 1998). It is second most important food crop after maize; accounting for approximately one-third of the total staple food production (Nweke, 1998).

In Cameroon, with about 4 million tons per year (Agristat, 2010), the crop is the first important food crop, mostly cultivated by subsistent farmers in mixed cropping systems made of maize, groundnuts, cocoyam, legumes and sometimes plantains. There is a plan underway in the country to move cassava from its current food crop status to an industrial one. However, the cassava production is limited by many factors including diseases causing significant yield losses (Wydra and Verdier, 2002).

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Major diseases depending on the cropping area include cassava mosaic disease (CMD) caused by Begomovirus, cassava bacterial blight (CBB) caused by *Xanthomonas campestris* (Pammel Dowson) *pv. manihotis* (Arthaud-Berthet) Starr. (Bondar, 1912) (synonym Xanthomonas axonopodis pv. *Manihotis* (Vauterin et al., 1995), anthracnose (CAD) caused by *Colletotrichum gloeosporioides f. sp. manihotis Henn. (Penz.) Sacc. (Glomerella manihotis Chev.*), brown leaf spot (BLS) caused by *C. (Mycosphaerella)* henningsii Allesch and white leaf spot (WLS) caused by C. caribaea Cif. (*Phaeoramularia manihotis*) as well as root rots (Wydra and Verdier 2002).

During the past decades, the International Institute of Tropical Agriculture (IITA) and collaborating partners have developed improved cassava varieties, with multiple resistances to pests and diseases (Mahungu et al., 1994; Fokunang et al., 2000; Dixon et al., 2002; Owolade et al., 2005; Wydra et al., 2006; Manyong et al., 2000) in Africa. The delivery of these resistant varieties, through the national programs for testing under specific local conditions during the late 1970s and 1980s, has led to the widespread and successful deployment of CMD- and CBB-resistant cassava in sub-Saharan Africa (Manyong et al., 2000). However, severe type of some diseases like CMD has been reported in certain parts of Africa (Legg and Fauquet, 2004; Bigirimana et al., 2004; Were et al., 2004; Bull et al., 2006). Thus, status of diseases infestation throughout the cassava growing regions of Africa required regular updating especially when new varieties are introduced as is the case in Cameroon.

Former surveys on cassava diseases in Cameroon (Wydra and Nsikita, 1998) reported separately most of the predominant diseases listed above but with various incidences and severities depending on the agro-ecozone. The most recent survey reported for the first time, the occurrence of the recombinant virus associated with the severe CMD in Eastern Cameroon (Akinbade et al., 2010).

To intensify the production of cassava, the Cameroon National Program for Roots and Tubers Development (PNDRT) - Cameroon in collaboration with IITA have introduced in 2007 and 2008, improved cassava varieties that have undergone extensive testing in the Country (Njukwe et al., 2005; 2007; 2013; 2014). As part of the follow up, the aim of the present work was to document potential changes in diseases status triggered by the introduction of these improved cassava varieties. We evaluated both local and introduced varieties in selected localities within the five antennae of the PNDRT and compared their diseases status. We then provide an overall review of the current management strategies of major cassava diseases in Cameroon.

2. Material and methods

Two main surveys were conducted: one from February to March 2008 and the second between December 2008 and March 2009. These periods correspond to long dry seasons in sites with bimodal rainfall pattern. These seasons were considered because, the present study was conducted in combination with pest evaluation (unpublished data) whose expression is more obvious in dry season.

2.1. Survey sites

PNDRT operating area consisted of five antennae viz: Bamenda, Bertoua, Douala, Ebolowa and Ngaoundéré representing agroecological zones. Each antenna comprises about 250 villages or pilot sites (for more details see Njukwe et al., 2013). Cassava cutting were distributed through farmer organizations whose representatives received training on rapid multiplication technique at the IITA Cameroon station. These organizations had the responsibility of multiplying and disseminating the introduced varieties in surrounding villages. In each antenna, our surveys focused in about two to four sites per survey (Fig. 1) depending on the accessibility. Most of the surveyed sites were multiplication fields (four to nine months old) belonging to farmer organizations. Accordingly, a farmer field with local varieties was selected not far from the multiplication field and considered as a check.

2.2. Varieties evaluated

Both local varieties and IITA improved varieties were evaluated in all the antennae but not in all the sites visited because improved varieties were either not available or in advanced developmental stage. Local varieties included about 41 accessions identified with the help of farmers in their local language. Of the ten varieties introduced, eight were Breeder seeds (BBulk P6, 8085, 880713, 880477-2, 92/0057, 95/0109, 96/0023, 96/1762) managed by elite farmers and two were Foundation seeds (92/0326 and 96/1414) cultivated under farmers' condition. These varieties were selected based on the result of extensive testing in the Country (Njukwe et al., 2005; see also Zundel et al., 2010; Njukwe et al., 2014).

2.3. Methods

Inspection of plant organs was done visually. The following scoring scale developed by Hahn et al. (1980) and commonly used for such study was used for diseases assessment (Fokunang et al., 2000; see also Sseruwagi et al., 2004): CMD: 1= no symptoms observed; 2 = mild chlorotic pattern over entire leaflets or mild distortion on base of leaflets with the rest of the leaflets appearing green and healthy; 3 = strong mosaic pattern throughout leaf, narrowing and distortion of lower one-third of leaflets; 4 = severe mosaic, distortion of two-thirds of leaflets and general reduction of size; 5 = severe mosaic, distortion of four-fifth more leaflets, twisted and misshapen leaves; CAD: 1= no symptom; 2 = shallow cankers on stems, lower down the plants; 3 = successive cankers higher up the plant with cankers on older stems becoming larger and deeper; 4 = dark-brown lesions on green shoots, petioles and leaves, young shoots collapsed and distorted; 5 = wilting, drying up of shoots and youngleaves, and death of part or whole plant; CBB: 1 = no symptoms; 2 = only angular leaf spots 3 = extensive leaf blight and leaf wilt, defoliation gum exudation of stem and petioles; 4 = extensive leaf blight, wilt, defoliation and stem dieback; 5 = complete defoliation and stem tip dieback of the shoots.

2.4. Data analysis

Diseases incidences were calculated as the percentage of attacked plant in each surveyed field. Mean incidences were

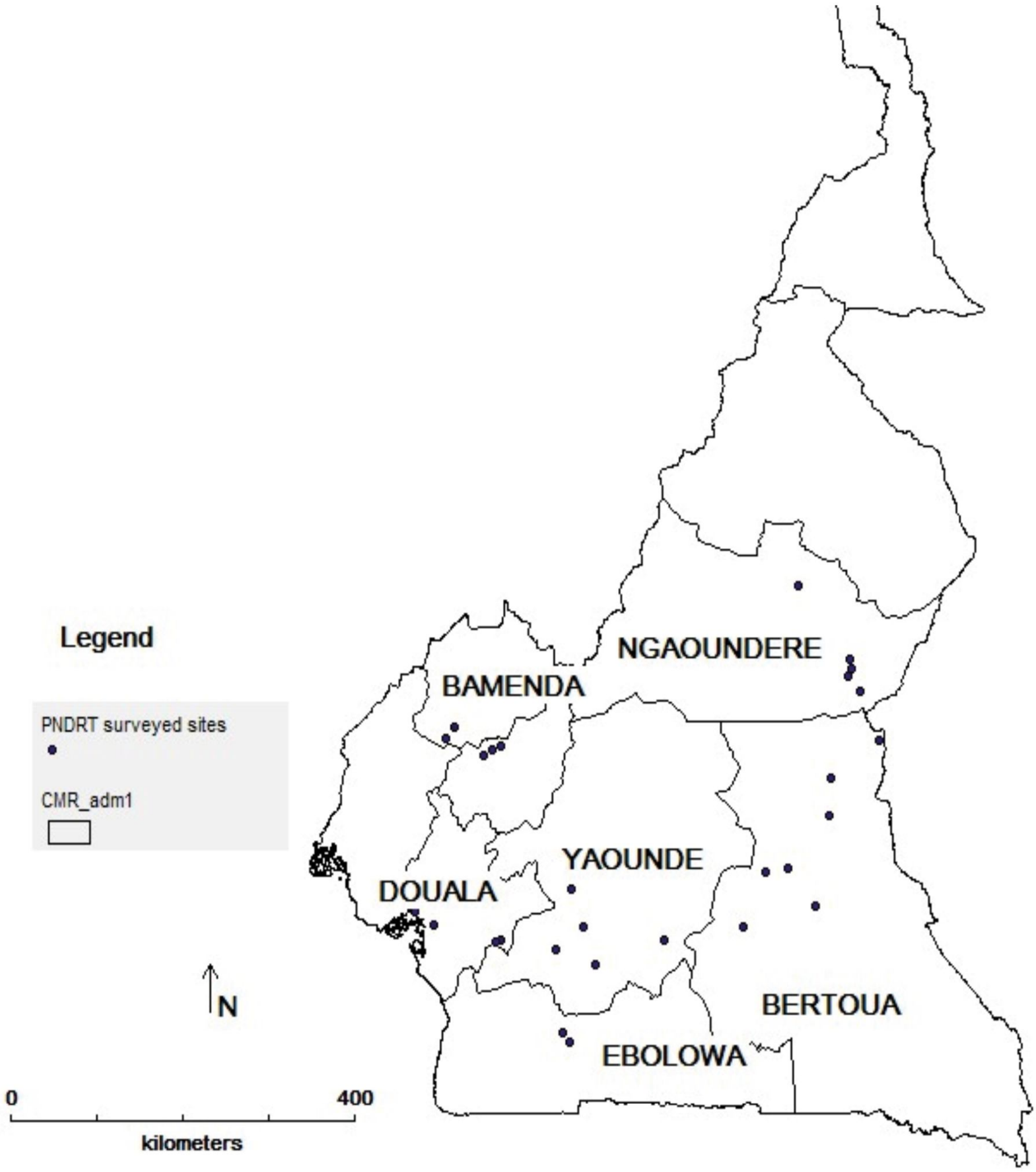

Figure 1. Surveyed sites for cassava diseases status in the Cameroon National Program for Roots and Tubers Development (PNDRT) operating area in Cameroon (from March 2008 to February 2009).

attacked plant in each surveyed field. Mean incidences were compared between antennae and varieties (local and improved) using the Generalized Linear Model (GLM) procedure of SAS software and Student-Newman-Keuls Test (SNK) was used for mean separation. The mean diseases damage scores were also compare between antennae and varieties using the same procedure.

3. Results

Symptoms of the following diseases were observed in cassava fields: the CMD, the CAD, the CBB, the cassava root rot (CRR), cassava brown leaf spot and cassava white leaf spot. But the later were not evaluated. Mean incidences and damages scores for the three predominant diseases recorded during the first and the second surveys are summarized in Table 1 and Table 2 respectively.

During the first survey, the CMD incidence varied significantly between antennae ($P < 0.05$) and between varieties ($P < 0.0001$). It was higher in Ebolowa and moderate in Bertoua, Bamenda and Douala but very low in Ngaoundéré. It was higher in local varieties compared to improved varieties (Table 1). Mean damages scores were generally mild (less than level 2) and varied significantly between antennae ($P < 0.0001$) and between varieties ($P < 0.0001$). The highest mean score was observed in Ebolowa while

Table 1. Diseases incidence recorded in cassava fields during surveys conducted from March 2008 to February 2009.

Antenna/ Varieties	CMD		CBB		CAD	
	1st survey	2nd survey	1st survey	2nd survey	1st survey	2nd survey
Bamenda	26.3±40.1b	08.7±21.3c	56.3±31.2b	53.9±35.1b	02.5±05.7d	02.0±04.1c
Bertoua	32.2±24.4b	11.0±28.1c	36.7±30.0b	41.0±35.1b	14.4±14.2c	18.0±32.9b
Douala	25.1±27.8b	50.0±57.7b	80.0±36.2a	50.0±42.4b	34.2±35.3b	00.0±00.0c
Ebolowa	51.4±38.0a	79.4±28.0a	80.0±16.3a	71.9±32.9a	60.0±23.8a	35.0±31.6a
Ngaoundéré	12.5±18.9c	16.4±36.4c	47.5±40.3b	20.9±35.1c	10.0±14.1c	02.7±04.7c
Locals	49.6±33.4	66.3±37.8	65.0±35.4	65.7±36.5	26.4±31.2	17.0±23.8
improved	06.5±12.3	00.3±01.7	53.0±31.5	34.4±33.2	13.5±21.8	13.1±29.7

The figures in table are the means value of data collected. Those within a column followed by different letter are significantly different at P < 0.05.

Antenna/ Varieties	CMD		CBB		CAD	
	1st Survey	2nd Survey	1st Survey	2nd Survey	1st Survey	2nd Survey
Bamenda	1.3±0.6c	1.1±0.5c	1.6±0.6c	1.5±0.6b	1.0±0.2c	1.0±0.1c
Bertoua	1.4±0.5c	1.3±0.6c	1.4±0.5d	1.4±0.5b	1.1±0.4c	1.1±0.4a
Douala	1.2±0.4b	1.7±0.7b	2.0±0.4a	1.5±0.5b	1.3±0.0b	1.0±0.0c
Ebolowa	1.6±0.5a	2.1±0.8a	1.8±0.4b	1.8±0.5a	1.7±0.6a	1.3±0.5a
Ngaoundéré	1.1±0.3c	1.2±0.4c	1.5±0.5c	1.2±0.4c	1.1±0.3c	1.0±0.2c
Locals	1.5±0.6	1.9±0.8	1.8±0.5	1.7±0.5	1.3±0.5	1.2±0.4
improved	1.1±0.2	1.0±0.1	1.6±0.5	1.3±0.5	1.1±0.4	1.1±0.3

The figures in table are the means value of data collected. Those within a column followed by different letter are significantly different at P < 0.05.

cassava was almost free of CMD damages in Ngaoundéré. When the CMD was present, local varieties were more attacked than improved varieties (Table 2).

During the second survey the pattern was almost the same as during the first survey. The CMD incidence also varied significantly between antennae (P < 0.0001) and between varieties (P < 0.0001). It was higher in Ebolowa and Douala but low in Ngaoundéré, Bertoua and, Bamenda. The incidence was still higher in local varieties than improved ones (Table 1). Mean damages scores were generally mild (less than level 2) and varied significantly between antennae (P < 0.0001) and between varieties (P < 0.0001). Corroborating the incidence, the highest mean score was observed in Ebolowa, then Douala, while cassava was almost free of CMD damages in Ngaoundéré (Table 2). Local varieties were more attacked than improved varieties.

During the first survey, mean CBB incidence and varied significantly between antennae (P < 0.05) but not between varieties (P > 0.05). It was higher in Ebolowa and Douala compared to Bamenda, Ngaoundéré and Bertoua (Table I). Mean damages scores were generally mild (less than 2) and varied significantly between antennae (P < 0.0001) but not between varieties (P > 0.05). The highest mean score was observed in Douala followed by Ebolowa. Damages were very low in other antennae. The higher score observed was also 3 at Banga-Bakoko, Mbomono-Babengue (Douala antenna) on local varieties; Bamendjin (Bamenda antenna) on improved varieties 95/0109 and 880477-2 and at Wossing (Bamenda) on improved variety 96/1414.

During the second survey, the CBB incidence also varied significantly between antennae (P < 0.01) and between varieties (P < 0.001). It was higher in Ebolowa compared to Bamenda, Douala and Bertoua. It was low in Ngaoundéré. The CBB incidence was higher in local varieties than improved varieties (Table 1). Mean damages scores were also generally mild (less than 2) and varied significantly between antennae (P < 0.0001) and between varieties (P < 0.0001). Higher damages scores were observed in Ebolowa antenna. Local varieties were more attacked than improved varieties (Table 2).

During the first survey, the CAD incidence varied significantly between antennae (P < 0.0001) but not between varieties (P > 0.05). It was higher in Ebolowa, moderate in Douala and low in

Bertoua, Ngaoundéré and Bamenda (Table 2) and was completely absent in Douala. Mean damages scores were also generally mild (less than 2) and varied significantly between antenna ($P < 0.0001$) and between varieties ($P < 0.05$). Local varieties were more attacked than improved varieties (Table 1).
No symptoms of the CRR were observed on all the uprooted cassava plant in all sites during the first survey. However, they were observed during the second survey on improved varieties 95/0109 and in Meiganga (two out of the 10 uprooted plants). Stem rot was found only once during the first survey in Bityili (Ebolowa antenna) on a local variety called Ekobele which was more than 12 months old.

4. Discussion and conclusion

Regular monitoring of diseases status is an important step in the integrated plant health management scheme. It helps raising awareness on new or outbreak of biotic constraints to plant production and the timely deployment of control options. Our study took the opportunity of the evaluation of introduced plant material in selected area to also review the current status of cassava disease management in Cameroon. This is opportune considering that the government of Cameroon has recently approved the introduction and distribution of new improved varieties from the IITA (M.T. Pers. Obs.). Also, local breweries and food industries are currently engaging their selves toward using cassava starch as a raw material (M.T. Pers. Comm.). Therefore, many initiatives are on the way to supply this considerable demand for cassava production. Diseases component responsible for considerable production loss should be also considered in this scheme.
The present study was conducted during dry seasons because it was combined with pest evaluation (unpublished data) whose expression is more obvious during dry season. This season is probably not adequate for diseases evaluation whose expression seems to be more obvious during the wet season. However, even if surveys were conducted during dry season, there was some out season rain during the second survey which might have elucidated disease expression. Therefore, out of diverse diseases known to occur on cassava in sub-saharan Africa (Wydra and Msikita, 1998; Wydra and Verdier 2002; Ntonifor et al., 2005; Legg and Trensh 2000; Hillocks and Wydra, 2002), the following were observed and evaluated: CMD, CAD, CBB and to lesser extend the cassava root rot. The brown and white leave spot were also observed but not evaluated due to their low economic importance (Lozano and Booth, 1974; Silva et al., 1988).
The CMD is the most important disease of cassava and has been reported in all cassava-growing countries in Africa. CMD causes mosaic and leaf distortion, leading to defoliation and severe plant stunting. It was first detected in Uganda in 1928 (Martin, 1928) but has been considered a minor problem with limited impact on the cassava production. Severe epidemics were reported between 1933 and 1944, but were successfully controlled by the use of resistant cassava varieties and by sanitation of infected plants (Otim-Nape et al., 1997). Previous surveys in Africa reported that occurrence of CMD across ecozones is contradictory and is probably under the influence of environmental factors and the intensity of cassava cultivation (Wydra and Msikita, 1998; Wydra and Verdier, 2002; Ntonifor et al., 2005; Legg and Trensh, 2000; Hillocks and Wydra, 2002). In Cameroon, severity of CMD has been reported to be mild to severe (Legg et al., 2004). Since the late 1980s, an epidemic of unusually severe CMD, initially reported from north-central Uganda, expanded to cover a large part of East and Central Africa with devastating effects on cassava production (Legg, 1999; Legg and Fauquet, 2004; Gibson et al., 1996; Legg et al., 2001; 2004; Neuenschwander et al., 2002; Bigirimana et al., 2004; Were et al., 2004; Bull et al., 2006). In Cameroon, the severe CMD has only been reported recently in the Adamawa region bordering the Central Africa Republic (Akinbade et al., 2010). The CMD is caused by several viruses belonging to the genus Begomovirus (family Geminiviridae) transmitted by the whitefly, B. tabaci. In Africa, several distinct species of virus are associated with CMD, namely African cassava mosaic virus (ACMV), East African cassava mosaic virus (EACMV), East African cassava mosaic Cameroon virus (EACMCV), East African cassava mosaic Kenya virus (EACMKV), East African cassava mosaic Malawi virus (EACMMV), East African cassava mosaic Zanzibar virus (EACMZV) and South African cassava mosaic virus (SACMV) (Fondong et al., 2000). Zhou et al., (1997) and Deng et al., (1997) reported a new cassava mosaic virus in Uganda (EACMV-UG1), which is considered to be a natural recombinant between ACMV and EACMV. This new virus is associated with the severe Ugandan epidemic of CMD (Harrison et al., 1997). The severe outbreak of CMD has been also attributed to a synergistic interaction between African cassava mosaic virus (ACMV), the East African cassava mosaic virus (EACMV), and the recombinant strain EACMV-UG (Deng et al., 1997; Zhou et al., 1997; Pita et al., 2001). In Cameroon, species found associated with CMD are African cassava mosaic virus (ACMV), East African cassava mosaic Cameroon virus (EACMCV) and East African cassava mosaic virus (EACMV) Fondong et al. (2000). The severe strain (EACMV-UG) was associated with the severe CMD reported recently in the Adamawa region bordering the Central Africa Republic (Akinbade et al., 2010). Single infection of ACMV was the most frequent and EACMV/EACMCV, and mixed infections of ACMV with EACMV/EACMCV were detected. Also the EACMV-UG, was reported as a mixed infection with ACMV and/or EACMV/EACMCV (Akinbade et al., 2010). The most promising method of controlling the CMD is breeding resistant varieties. Breeding for resistance began at the IITA in 1971 and built on the hybrids developed at the Amani research station in Tanzania by Colonial governments. New mosaic-resistant varieties called TMS series were developed and their delivery to farmers through national programs has led to the widespread and successful deployment of CMD resistant cassava in sub-Saharan Africa (Manyong et al., 2000). In Cameroon, after the creation of Cameroon National Root Crops Improvement Program, several varieties resistant to CMD were released and distributed to growers. Among these varieties were 8034, 8061, 8017, 820516, 1005, 1187, 1198, 224, 465, and 8117 (Ngeve et al., 2010). The introduction of these varieties could explain the reported mild to severe CMD status in Cameroon. To prevent the progression of

the severe strain of CMD, IITA is now introducing resistant genotype in the Eastern region of Cameroon (R.Hanna Pers. Comm.).

The Cassava Bacterial Blight, caused by *Xanthomonas axonopodis pv. manihoti* is a major constraint to cassava cultivation worldwide. Field symptoms include water-soaked angular leaf spots, blighting, wilting, defoliation, vascular necrosis of the stem, production of exudates on leaves, petioles or stems, and stem dieback (Lozano, 1986; Msikita et al., 1998). Root yield losses exceeding 50 to 75% depending on the severity of the disease, or complete loss of yield and planting material in case of severe infections were observed (Wydra and Rudolph, 1999; Wydra 2002; Zinsou et al., 2004). In the nineties, an increased severity of bacterial blight with regionally serious outbreaks was observed in Africa (Boher and Agbobli, 1992; Wydra and Msikita, 1998; Banito et al., 2001). CBB incidences were reported to be higher in the savannah zones than in the forest transition and rain forest zones (Wydra and Msikita, 1998). This prevalence in the savanna zones has been attributed to the survival of the causal organism in plant debris during the dry season (Persley, 1979). CBB distribution was described in Cameroon with variable incidence and severity according to ecozones (Wydra and Msikita, 1998). Results from the present study indicating that incidences of CBB were higher in humid forest area compared to other ecozones, are not in line with previous findings but corroborated those by Bafemka et al., 2011 in Guinea. Haln et al., (1989) also reported that the severity and incidence of CBB are highly correlated to the amount of rainfall. The only practicable means of controlling CBB is the use of resistant lines. IITA has developed cassava varieties both resistance to CBB and CMD (Hahn, 1978; Mahungu, 1984; Dixon et al., 2002). This material has been widely and successfully deployed in Sub Saharan Africa (Manyong et al., 2000). This might explain why mean damages scores observed during the present study were also generally mild (less than 2) and local varieties more attacked than improved varieties.

The cassava anthracnose disease (CAD) has a world-wide distribution (Lozano et al., 1981). It is caused by *C. gloeosporioides (Penz) f. sp. manihotis Chev.* CAD infection is characterized by deeper cankers, causing stems to become brittle and easy to break by wind action. The most outstanding effect of the disease is its ability to cause severe stem damage, wilting of leaves and diebacks. The overall effect of these is the reduction in yield and in the amount of healthy plantable stems available to the farmers. In Africa, CAD is considered to be of major importance. Makambila (1987) reported that more than 80% cassava plants in Congo showed CAD symptoms. Wydra and Msikita 1998 reported a high incidence of CAD across the countries of the rainforest and transition forest and transition zone. Breeding for resistance to cassava anthracnose disease appears to be the most efficient means of control of CAD (Hahn et al., 1989). However, despite the progress made in resistance breeding to main cassava diseases in Africa (Mahungu, 1984; Dixon et al., 2002), CAD has been rarely taken into consideration. Thus, significant incidence and damage differences were hardly found between improved and local varieties during the present study. Although the severity has been mild, the selection of resistant varieties and continuous breeding for CAD resistance should be reinforced.

Cassava root rots are reported to be common in Africa, Asia and Latin America (Onyeka, 2002; Onyeka et al., 2004; Bandyopadhyay et al., 2006). They are caused by a wide range of fungal and bacterial pathogens including *Botryodiplodia theobromae, Fusarium oxysporum, F. solani, Aspergillus niger, A. flavus, Sclerotium rolfsil, Armilleria melea, and Trichoderma* species. However, *B. theobromae* is the commonly isolated fungi. Damages include the loss of leaves, dieback in stems and shoots, and root deterioration. Amongst major cassava diseases, root tots are the most poorly understood probably because pathogens affect mostly the underground part of the plant (Bandyopadhyay et al., 2006; Afolali et al., 2010). In Southern Cameroon, 36% of interviewed farmers have been pointing root rot as a second most important constraint to cassava production. However, Survey by IITA (2004) and Messiga et al. in 2004 reported very low incidence and severity of root rot. Complete rotting of tubers in few plants was observed in only two villages in field more than 12 months. This figure is supported by the results from the present study. Onyeka (2002) reported very significant increases in rot intensity when cassava plants were left in the field for up to 15 months after planting in Nigeria. Afolabi et al. (2010) observed high level of rot on improved varieties and argued that it was largely due to the length of time they had stayed in the field (age of the crop) and the excessive rainfall. However, the ability of the local varieties to stay for 2-3 years longer on the field than the improved varieties suggest that they possess heritable characteristics that can be incorporated into the high yielding improved varieties. Therefore, there is need for cassava breeders to look at these quality traits in local varieties and incorporate some in the improved varieties for better performance.

5. Conclusion

Results obtained during the present study clearly indicate that the introduction of improved cassava varieties has significantly reduced the incidence and severity of CMD and CBB effect on cassava development and consequently on yield. Despite this achievement, CAD and root rot remain a problem for cassava production in Cameroon. Collaborative effort should therefore continue to develop, select and introduce resistant material against major diseases.

Acknowledgements

This work was funded by the Cameroon National Program for Roots and Tubers Development (PNDRT-Cameroon).

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