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REACTION OF LOCAL ACCESSIONS OF CASSAVA TO DISEASES IN SOUTHERN GHANA

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ABSTRACT

Local accessions of cassava (*Manihot esculenta* Crantz) are extensively grown in Southern Ghana, where they play an important role in food security of the country. Information on the reaction of these local accessions to major diseases is scanty. This study was conducted to document the reaction of these accessions to diseases. Seventy seven accessions collected from 55 districts in southern Ghana were screened in a high disease pressure zone for seven years. Several of the accessions cultivated by farmers were found to be susceptible to African cassava mosaic disease (ACMD), cassava bacterial blight (CBB), cassava anthracnose disease (CAD) and brown leaf spot (BLS). Using DNA hybridisation and Enzyme Linked Immunosorbent Assay (ELISA) techniques, a number of accessions were found to be capable of resisting the ACMD virus. *Polyporus* root rot disease was found on few farms in the Ashanti region. Bud necrosis disease of cassava was found in a number of farms in the humid rain forest areas of Ashanti and Brong-Ahafo regions. Disease control in cassava production was found to be highly limited in all the southern Ghana regions.

Key Words: Cassava bacterial blight, *Manihot esculenta*

RÉSUMÉ

Les accessions locales du manioc (*Manihot esculenta* Crantz) sont largement cultivées dans le Sud du Ghana, où ils jouent un rôle important dans la sécurité alimentaire du pays. Peu d'informations sont disponibles sur la réaction des écotypes locaux aux pathologies majeures des plantes. La présente étude a été réalisée pour pallier cet état de chose. Soixante-dix-sept accessions collectées de 55 districts dans le Sud du Ghana ont été évaluées dans une zone de forte pression pathogénique pendant sept années. Un grand nombre des accessions cultivées par les agriculteurs ont été révélées susceptibles à la mosaïque du manioc (ACMD), la bactériose du manioc (CBB), l'anthracnose (CAD) et aux lésions brunes rondes (BLS). En utilisant la technique d'hybridation de l'ADN et l'essai d'immuno-absorption enzymatique (ELISA), un nombre important de ces accessions ont été vus capable de résister au virus de la mosaïque du manioc. La pourriture des racines causées par les polypores a été observée dans quelques champs des régions Ashantis. La nécrose des bourgeons de manioc a été recensée dans beaucoup de champs des zones de forêt humide des régions Ashanti et de Brong-Ahafo. La lutte contre les maladies dans la production du manioc est très limitée dans toutes les régions du Sud Ghana.

Mots Clés: la Bactériose du manioc, *Manihot esculenta*

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is Africa's second most important staple food in terms of per *capita* calories consumed. In some sub-Saharan African countries, cassava is consumed daily, and sometimes more than once a day. In the Congo, Tanzania, Sierra Leone and some parts of West Africa, cassava leaves are consumed as a vegetable. Cassava is a major food security

crop in some parts of sub-saharan Africa where it is grown. It has been reported that communities that better survived the famine in the early 1980s in Ghana were those that had field crops of cassava (Fresco, 1993). Available reports indicate that famine rarely occurs in areas where cassava is extensively cultivated because it provides a stable base to the food production system (Nweke *et al.,* 2002). Cassava roots provide starch as a raw material for several local industries in several parts of Africa (Banito *et al.,* 2008).

Diseases are major constraints to production of cassava wherever the crop is grown. African cassava mosaic disease (ACMD) reportedly causes yield losses that may range between 50 and 90% in zones where susceptible cultivars are grown (Thresh *et al*., 1994, 1997; Moses, 2009). The ACMD pandemic in East Africa in the 1990s created food shortages in countries that depended on cassava for their food security (Otim-Nepa and Tresh, 1998).

Over 90% of local cultivars of cassava in Congo were reportedly severely infected by cassava anthracnose disease CAD (Fokunang *et al*., 2001). CAD causes yield losses as high as 30% in susceptible cultivars and affects the availability of healthy planting materials (Cook, 1978; Moses, 2009). Cassava bacterial blight (CBB) potentially causes total crop failure and was responsible for famine in Congo and Nigeria in the 1970s (Williams *et al*., 1973; Lozano, 1986). Diseases such as *Polyporus* root rot could cause complete crop failure where susceptible cultivars are grown (Moses *et al.,* 2008; Moses, 2009).

These diseases pose threats to food security wherever susceptible cultivars of cassava are extensively depended on. There is, therefore, need to develop reliable information on local accessions depended on extensively for food production with respect to diseases. This study was aimed at establishing the existence or availability of local accessions of cassava with resistance to the major diseases (ACMD, CBB and CAD).

MATERIALS AND METHODS

Cassava accessions. A survey to collect cassava accessions with suspected resistance or tolerance to major diseases, ACMD, CAD and CBB was conducted during 2001and 2002 in 55 cassava growing districts in the southern regions of Ghana (Ashanti, Brong-Ahafo, Western, Eastern, Greater Accra, Central and Volta). In each district, 10 to 20 farms were randomly selected depending on the size of the district and examined for disease resistant or tolerant accessions. Mature accessions (7 months old or more), which did not show symptoms of diseases, were collected for on-station screening. Collected accessions were also free from symptoms of root-rot diseases.

On-station screening. Reaction of 77 collected accessions to diseases was studied at a hot spot for all major diseases of cassava in the fields of the Root and Tuber Division of the CSIR-Crops Research Institute, Fumesua Station (near Kumasi, Ghana).

Disease-free cuttings of all collected accessions were planted on plots of 5 m x 5 m or 5 m x 10 m, depending on the amount of planting materials available. Planting distances of one metre was maintained between plants. A local accession, 'Amakuma', highly susceptible to all the major diseases of cassava including CBB, was planted in between test plots as a check to serve as a spreader row to increase disease pressure on the test genotypes. Each cultivar was replicated three times. In addition, 'Afisiafi' (a released improved variety with reported resistance to ACMD, CBB and CAD) was included to ensure effective comparison. Plots were well maintained and disease progress assessed regularly, using a 1-5 scale (where 1= no symptom observed; 5= symptoms indicating irreparable damage observed) (IITA, 1994).

At harvest, planting materials of each of the accessions screened were collected and used for the following season's planting. Screening of an accession was discontinued in the following season if a cultivar succumbed to ACMD , CBB or CAD in the previous season.

Confirmation of ACMD resistance with DNA hybridisation. Leaf tissues of twelve cultivars that did not show any observable symptoms of ACMD and CBB (after three seasons field testing), were analysed for presence or absence of viruses, using DNA hybridisation procedures.

Following manufacturer's instructions, young leaves from the 12 accessions which had ACMD severity score of 1.0 at the end of the third season (Table 2) were crushed on membranes designed for the detection of geminiviruses supplied by Agdia Incorporated, USA.

Enzyme linked immunosorbent assay (ELISA) to confirm ACMD Resistance. Leaves from six accessions of cassava, which did not show symptoms of ACMD after four seasons on-station testing, were tested for the presence or absence of viruses using indirect enzyme-linked assay methods (Adams and Barbara, 1982). After coating with the polyclonal ACMV antibody, two specific monoclonal antibodies namely; SCR 33, specific to ACMV and SCR 23 specific to EACMV were used to detect their corresponding viral antigens in the samples. The developed colour was read at 490 nm using a Bio-RAD microplate reader. A sample was considered positive if the absorbance was greater than twice the mean absorbance of eight control wells of healthy leaves collected from tissue cultured plants (Amoatey *et al*., 2013).

RESULTS

Reactions of 37 accessions to diseases of cassava at the end of the second season of screening are presented in Table 1. The accessions were named after towns or districts where they were collected in southern Ghana to ensure that locations of origin could be re-visited if necessary. Forty accessions from the initial collection of 77 succumbed severely to either ACMD or CBB in the first season of screening.

Table 2 shows the 12 accessions of cassava tested for absence or presence of ACMV in leaf tissues using DNA hybridisation procedures. Six of these cultivars, Bechem-Techire-02, Techiman-06, Ahafo-Ano North-02, Sekyere West-02, Sewfi-Bekwai-01 and Sekyere West-05 were found to be free of the ACMD virus based on test results. Accessions Techiman-06 and Ahafo-Ano North-02 were susceptible to cassava anthracnose disease.

The reaction of the six accessions tested for the presence or absence of ACMD viruses using ELISA techniques at the end of the fourth season are shown in Table 3. Antiserum raised against ACMV reacted positively with antigens in two of the cassava accessions namely Techiman-06 and Sekyere West-05. The four other accessions, Bechem-Techire-02, Ahafo-Ano-02, Sekyere West-02 and Sewfi-Bekwai-01 reacted negatively to the antiserum raised against ACMV indicating absence of ACMV in the samples. The two accessions, however, succumbed to ACMD severely in the seventh season.

The improved variety, 'Afisiafi', popular for its high yielding and disease resistant attributes, succumbed to ACMD and CAD (Table 3). Bud necrosis disease of cassava was found in some parts of the Ashanti, Brong-Ahafo and Western regions. *Polyporus* root rot disease of cassava was found on few farms in Ashanti and Volta regions.

A total of 21 of the 26 accessions collected from Brong- Ahafo region did not show any visible sign of susceptibility to ACMD after one season on-station testing (Table 4). Twenty two of the 26 collected accessions, however, succumbed to CAD.

DISCUSSION

ACMD and CAD were the two major cassava diseases found to be widespread in the local accessions of cassava in Southern Ghana. The two diseases were present in all the 55 study districts. In several of these districts, the accessions were all susceptible to ACMD, CBB and CAD. Cassava bacterial blight was not widespread, but was on few farms. Brown leaf spot, often considered a minor disease of cassava was widespread, and contrary to farmers' remarks that this disease was associated with matured cassava plants, the disease was found on plants younger than 5 months.

Despite the widespread nature of ACMD, a number of accessions available to farmers in some districts had some level of resistance which sometimes lasted for four seasons under high ACMV pressures (Table 3). In ecologies with low disease pressures, it is possible that these accessions could be grown for more than four years before they finally succumb to the virus. These accessions could be depended on to manage ACMD to increase production.

TABLE 1. Reaction of 37 accessions of cassava to diseases at the Crops Research Instittute's Fumesua Station in Ghana

Accessions of cassava	ACMD	CBB	CAD	BLS
Jasikan- 01	1.0	1.0	3.0	1.0
Techiman-01	1.0	1.0	3.3	3.3
Techiman-03	1.0	1.0	4.2	3.0
Ahafo Ano North-02	1.0	1.0	4.0	2.0
Wamfie -01	1.0	1.0	3.3	3.3
'Amakuma' (check)	5.0	1.0	5.0	2.5
'Afisiafi' (improved variety -check)	2.3	1.0	4.0	2.0
Sekyere West-02	1.0	1.0	2.3	2.5
Sewfi Bekwai-01	1.0	1.0	2.3	2.0
Sekyere West-05	1.0	1.0	2.6	2.6
Bechem-Techire-01	1.0	1.0	2.0	2.6
Bechem-Techire-02	1.0	1.0	2.0	2.0
Bechem-Techire-03	1.0	1.0	2.0	2.5
Sekyidomase -01	4.2	4.3	1.0	4.0
Nkoranza-02	2.0	4.3	1.0	3.3
Techiman-04	4.3	3.0	1.0	3.3
Techiman-05	3.3	4.0	1.0	3.0
Nkoranza-03	3.0	3.6	1.0	2.0
Dorma-03	3.2	3.0	1.0	1.0
Sekyidomase-05	1.0	4.2	1.0	3.6
Dorma-01	3.0	3.6	1.0	1.0
Techiman 06	1.0	1.0	3.3	3.3
Techiman-07	2.3	3.3	1.0	3.0
Dorma-02	1.0	4.0	1.0	1.0
Ahafo-Ano North-03	3.3	3.0	1.0	1.0
Techiman-08	2.3	4.3	1.0	3.3
Ahafo-Ano North -04	3.6	3.3	1.0	3.6
Kwaso-01	2.3	2.3	1.0	3.0
Brekum -01	1.0	1.0	1.0	3.3
Techiman -08	3.3	3.3	1.0	2.0
Swedru-01	3.3	4.0	1.0	2.0
Ajumako-01	3.0	1.0	1.0	3.0
Mpohor-01	4.2	3.3	1.0	1.0
Bibiani-01	3.3	3.3	1.0	2.3
Sameriboi-01	1.0	4.0	1.0	3.0
Mankessim-01	4.0	2.3	1.0	2.0
Mankessim-05	3.6	3.0	1.0	2.3
Assin Swedru-01	3.3	5.0	1.0	2.0
Swedru-05	1.0	1.0	1.0	2.3

Figures represent disease severity scores on 1 - 5 scale (where 1 = no symptom observed; 5 = symptoms indicating irreparable damage observed). ACMD = African cassava mosaic disease, CBB = cassava bacterial blight, CAD = cassava anthracnose disease, BLS = brown leaf spot

Programmed multiplication and distribution of these relatively resistant accessions to farmers at the district or regional levels would be a good strategy to reduce the effects of ACMD. Farmers, however, need to be trained in disease identification to know when their planting materials need to be replaced with new healthy stock (Tresh and Otim-Nape, 1994; FAO, 2011).

Cassava anthracnose disease and CBB could be managed through the adoption of good cultural practices. Results of similar studies (where several genotypes, including improved

TABLE 2. Reaction of accessions that continued to show resistance to ACMD after three seasons screening on-station at Crops Research Insttitute's Fumesua Station in Ghana

Accessions of cassava	ACMV	CBB	CAD	BLS
Jasikan-01	1.0	1.0	3.3	1.0
Techiman-01	1.0	1.0	3.0	3.0
Bechem-Techire-02	1.0	1.0	2.3	2.0
Techiman 06	1.0	1.0	3.0	3.3
Ahafo-Ano North-02	1.0	1.0	4.3	2.0
Wamfie-01	1.0	1.0	4.0	3.3
'Amakuma' (check)	5.0	1.0	5.0	2.0
'Afisiafi' (check)	2.3	1.0	4.3	2.6
Sekyere West-02	1.0	1.0	2.0	2.0
Sewfi Bekwai-01	1.0	1.0	2.6	2.0
Sekyere West-05	1.0	1.0	2.0	2.6
Swedru-05	1.0	1.0	3.0	1.0
Brekum -01	1.0	1.0	1.0	3.3
Bechem-Techire-03	1.0	1.0	3.3	3.0

Figures represent disease severity scores on 1 - 5 scale (where 1 = no symptom observed; 5 = symptoms indicating irreparable damage observed) (IITA,1994). ACMV = African cassava mosaic virus, CBB = cassava bacterial blight, CAD = cassava anthracnose disease, BLS = brown leaf spot

TABLE 3. Reaction of accessions that continued to show resistance to ACMD after four seasons on-station screening at Crops Research Institute 's Fumesua Station in Ghana

Accessions of cassava	ACMV	CBB	CAD	BLS
Sekyere West-0-2	1.0	1.0	3.0	2.0
Sekyere West-05	1.0	1.0	4.2	3.0
Bechem-Techire-02	1.0	1.0	2.0	2.6
Techiman 06	1.0	3.3	3.3	3.0
Sewfi Bekwai-01	1.0	1.0	3.0	2.6
Ahafo-Ano North-02	1.0	1.0	4.0	2.0
'Amakuma' (check)	5.0	1.0	5.0	2.6
'Afisiafi' (check)	3.0	1.0	4.3	2.0

Figures represent disease severity scores on a 1 - 5 scale (where 1 = no symptom observed; 5 = symptoms indicating irreparable damage observed) (IITA,1994). ACMV = African cassava mosaic virus, CBB = cassava bacterial blight, CAD = cassava anthracnose disease, BLS = brown leaf spot

varieties, were evaluated for CBB resistance) indicated that no cultivar with complete resistance to this disease was identified (Zinsou *et al.,* 2004; Banito *et al*., 2008). Good farm sanitation, including destruction of old plant debris through burning during land preparation is very useful in reducing inocula levels of CAD and CBB (Moses *et al*., 2008; Moses, 2009). Destruction of plant debris bearing lesions of diseases, followed by the use of healthy planting material may be enough to control or reduce the effects of CAD and CBB on farms (Lozano, 1986; Moses *et al*., 2008). Rotating cassava with grains and cereal crops at least at the end of every three seasons of each crop, could bring CBB and other diseases of cassava under control. Rotating crops belonging to different families disrupts the life cycles of important pathogens to help achieve disease control (Tilman *et al*., 2002).

TABLE 4. Reaction of accessions of cassava to diseases after one season on-station screening (collections from Brong-Ahafo Region in Ghana in 2011)

Accessions of cassava	ACMD	CBB	CAD	BLS
Sunyani-01	1.0	1.0	1.0	2.2
Sunyani-02	1.0	1.0	2.8	2.0
Nkoranza-01	1.0	1.0	2.5	2.3
Nkoranza-02	3.3	1.0	3.3	2.5
Nkoranza-03	1.0	1.0	3.3	3.0
Nkoranza-04	1.0	1.0	3.7	2.0
Nkoranza-05	1.0	1.0	3.7	2.7
Nkoranza-06	1.0	1.0	3.5	3.0
Nkoranza-07	1.0	1.0	3.8	3.0
Brekum-01	4.2	1.0	3.5	2.0
Brekum-02	4.2	1.0	3.0	3.0
Brekum-04	1.0	1.0	4.0	2.5
Brekum-05	1.0	3.3	1.0	2.0
Brekum-07	1.0	1.0	1.0	2.0
Dorma 01	1.0	1.0	3.5	2.5
Nkwanta-01	1.0	1.0	3.0	3.0
Nkwanta-02	1.0	1.0	3.5	3.0
Nkwanta-03	2.0	3.3	3.0	3.3
Nkwanta-04	1.0	1.0	4.0	2.5
Nkwanta-05	1.0	1.0	4.0	2.5
Nkwanta-06	1.0	3.0	3.5	2.3
Nkwanta-07	1.0	1.0	4.3	2.0
Nkwanta-08	1.0	1.0	2.5	2.5
Nkwanta-09	1.0	1.0	4.3	2.0
Nkwanta-10	1.0	1.0	4.0	3.3
Nkwanta-11	4.0	1.0	1.0	3.0

Figures represent disease severity scores on a 1 - 5 scale (where 1 = no symptom observed; 5 = symptoms indicating irreparable damage observed) (IITA, 1994). ACMD = African cassava mosaic disease, CBB = cassava bacterial blight, CAD = cassava anthracnose disease, BLS = brown leaf spot

Brown leaf spot disease, often considered a minor disease of cassava, needs to be considered more seriously. The disease was found to be widespread, and in susceptible accessions, attacked plants quite early in some fields. In highly susceptible cultivars, the brown spots may cover a great surface area of leaves and this may significantly reduce photosynthetic activities and, therefore, reduce yields (Bassanezi *et al*., 2001). The nature of spread of BLS disease needs to be understood to reduce its high incidence in the country before it gets out of hand.

Bud necrosis is a disease little mentioned among cassava diseases (Moses *et al*., 2008). The disease affects sprouting of stem cuttings in some humid parts of the Ashanti, Brong-Ahafo and Western regions. *Polyporus* root rot disease of cassava, also very little documented (Moses, 2009) was identified in few fields in Ashanti and Volta regions. This disease poses a threat to cassava production in the country (Moses, 2009). Sustained efforts in reducing effects and spread of these relatively new diseases into new areas are recommended. Introduction of local quarantine measures to prevent movement of cassava planting materials and cassava roots from *Polyporus* endemic areas, into *Polyporus*-free areas for example, could be enforced by the Plant Protection and Regulatory Services Division of the Minsitry of Food and Agriculture, Ghana. Farmers and Agriculture Extension Agents need to be well informed of these relatively new diseases.

A number of accessions collected from Brong-Ahafo region resisted the ACMD virus after the first season (Table 4). At the end of the fourth season in 2014, only Sunyani-01 had still not shown any symptoms of ACMD, CBB or CAD. The accession Nkoranza-01 has also not shown any symptoms of ACMD or CBB but was moderately attacked by CAD (at a disease severity score of 2.5). The other accessions in Table 4 succumbed severely to ACMD or CBB. In most of the districts in the Brong-Ahafo region, farmers cultivated accessions that are susceptible to ACMD. Advantage could be taken of the two accessions Sunyani-01 and Nkoranza-01 to manage ACMD and CBB in districts where susceptible accessions are largely cultivated by farmers. Advantage could be taken of accessions of cassava identified to possess disease resistance for the management of diseases in the region. Serious attention, however, needs to be paid to the control of CAD in this region, as several of its accessions are susceptible to the disease (Table 4).

It is important to note that the high disease resistance of the improved variety 'Afisafi' that was observed in the 1990s is breaking down. It is, thus necessary that improved varieties of cassava released primarily to control diseases are monitored regularly to ensure their replacement whenever necessary.

CONCLUSION

Diseases constitute a major constraint to cassava production in southern Ghana which produces the bulk of the country's cassava requirement. Despite this observation from this study, farmers in all the 55 districts covered in this study rarely controlled diseases of cassava. This situation may exist in several sub-Saharan African countries that grow cassava. Managing diseases of cassava effectively in this era of climate change, where poor rainfall pattern is affecting grain and cereal production, would be one of the best options to safeguard Ghana's food security which currently has inherent weaknesses. Farmers should be equipped with basic knowledge of diseases affecting their crops and the simple measures that could be practiced to control them.

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