

Prevalence of Cassava Root Rot Disease in the Brong Ahafo Region of Ghana

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ABSTRACT

Cassava root rot diseases contribute to substantial yield loss in cassava production. The study determined the incidence and severity of the cassava root rot disease in the Forest and Transition zones of the Brong-Ahafo Region; identified the disease pathogen; assessed farmers' knowledge on the disease and identified cultural practices that promote the disease. Six focus group discussions and a survey was carried out with 55 cassava farmers in the Dormaa East and Sunyani West Districts (Forest zone) and Nkoranza South Municipal (Transition zone) and their farms were sampled for rotten roots and laboratory investigations carried out. The highest mean disease incidence recorded at Amanfe (34.7%) was similar to that at Wamfie (31.4%); Kwatire (31.2%); Kyeremasu (31.0%); Merefrewo (30.8%); Nsoatre (27.2%); Kwasoa (24.6%); Asuakwa (21.0%) in the Forest zone. However, the mean incidence of the disease at Amanfe was significantly higher than that recorded at Wagadudu (17%); Sessima (12%); Akuropong (4%) and Asempanaye (8.1%) in the Transition zone. The highest mean severity score of 4 was recorded at Wamfie was not significantly different from that recorded at Amanfe (3); Kyeremaso (3); Merefrewo (3); Asuokwaa (3); Nsoatre (2) Kwaasoa (2) and Kwatire (2) in the Forest zone. However it was significantly higher than that at Sessima (1); Akuropong (0.5) and Asemapanaye (0.5) in the Transition zone. Mean disease incidence and mean severity of the cassava root rot disease is higher in the Forest than in the Transition zone. *Lasiodiplodia theobromae* was frequently isolated from the diseased samples. All the respondents were aware of the disease. Delayed harvesting; planting in waterlogged soils and high weed density were reported as the causes of the cassava root rot disease by 71%, 25.5% and 3.6% of the respondents. More than 70% had cultivated cassava continuously for at least three years; only 9.1% intercropped cassava with groundnut to improve soil fertility; none applied chemical fertilizer; and all the respondents retained mature roots in the ground for prolong periods. The farmers have a fair knowledge of the cassava root rot disease but they lack methods to control the disease. Unfavourable environmental conditions and poor farm management practices contribute to cassava root rot disease.

Keywords: *Manihot esculenta* Crantz., mixed cropping, resistant variety, inorganic fertilizer, *Lasiodiplodia theobromae*, cultural practices

INTRODUCTION

Cassava root rot diseases caused by soil-borne pathogens contribute to substantial yield loss in cassava production (IITA 1990; Makambila 1994). Reports indicate that fungi associated with cassava root rot disease include *Fusarium* spp. *Lasiodiplodia theobromae*, *Armillaria* spp, and *Phytophthora* spp. (Onyeka, 2002; Mwangi, *et al.*, 2004; Msikita *et al.*, 2005; Bandyopadhyay *et al.*, 2006). Research in Ghana has focused on the cassava root rot disease caused by *Polyporus sulphureus* Bull. Ex. Fr. (Opoku-Asiama *et al.*, 1998; Awaga, 2004; Moses *et al.*, 2007; Gyan 2009). Opoku-Asiama *et al.*, (1998) assessed the knowledge of cassava farmers in the Central Region of Ghana on *Polyporus sulphureus* infection and established the average incidence in the range of 13- 47 % in the region. The results indicated that 68.4% of cassava farmers in the region were aware of the disease and had encountered it on their farms. Similar study conducted by Awaga, (2004) established the extent of spread of *P. sulphureus*, identified cassava varieties resistant to the disease and evaluated control measures adopted by farmers in the Central region. He revealed that *P. sulphureus* was prevalent in Bobikuma, Kwanyako and Nsaba out of the 15 towns covered in the survey. The fungus was present in all soil types studied throughout the year and cassava plants aged between two to twelve months were affected. In that study the improved variety *Afisiafi* was more tolerant to *P. sulphureus* while the local cultivar *Bosomensia* was most susceptible. Farmers did not implement any control measure. Moses *et al.*, (2007) quantified the incidence and severity of *P. sulphureus*; determined its host range; identified the cultural practices that promote the spread and persistence of the disease and screened cassava varieties for resistance to the disease in Southern Ghana. Results of the study indicated that *P. sulphureus* is present in Volta, Ashanti, and Central Regions of Ghana. A number of woody plants including citrus and some weed species were identified as alternate host plants to the pathogen. Some local and improved genotypes of cassava available to farmers were also susceptible to the fungus. Cultural practices that promoted the spread and persistence of the disease were found to be poor farm sanitation, continuous cropping of the same piece of land to cassava, movement of unprocessed roots and planting materials from endemic areas to new localities and cropping of new fields with history of the disease. A study conducted later by Gyan (2009) to screen ten improved varieties of cassava for resistance to *P. sulphureus* in the Western region of Ghana indicated that apart from *Tekbankye*, an improved variety, all the others varieties were susceptible to the disease.

Recent report by farmers indicated that a root rot disease is widespread in fields with mature cassava plants in the Brong- Ahafo Region of Ghana. The disease is characterized by dark brown patches in the storage root tissue, breakage of stems at the base, browning of leaves and defoliation of the plant, lodging and wilting of the whole plant together with rotting of the storage roots (Bua and Okello, 2011). Though these symptoms are similar to that of *Polyporus sulphureus* infection, the conspicuous bright yellow fruiting body formed at the base of cassava plants with *Polyporus sulphureus* infection is absent (Moses *et al.*, 2007). The current study was undertaken as part of a larger study that is aimed to increase cassava yields in the Brong-Ahafo Region of Ghana by introducing appropriate farm management

strategy to reduce the incidence of the cassava root rot disease. The specific objectives of the study were (i) to determine the incidence and severity of the cassava root rot disease in farms in the Forest and Transitions zones of the Brong-Ahafo Region; (ii) to identify the disease pathogen of the cassava root rot disease; (iii) to assess farmers' knowledge on the cassava root rot disease and (iv) to identify farmers' practices that promote the disease.

METHODOLOGY

Study Areas

The study was carried out in the Dormaa East and Sunyani West Districts and Nkoranza South Municipal of the Brong Ahafo region from August to November, 2014. The Dormaa East is located between latitude 7° 08'N and 7° 25'N and longitude 2° .35'W and 2° .48'W and the Sunyani West district between latitude latitudes 7° 19'N and 7° 35'N and longitudes 2° 08' W and 2° 31'W and both are in the Forest zone of Ghana. The Nkoranza South Municipal lies within longitudes 1°10"W and 1°55"W and latitudes 7°20"N and 7°55"N and is situated in the Transition zone. The three study areas were selected based on reported cases of cassava root rot disease in the Brong- Ahafo region. All three areas are located within the wet semi-equatorial climate and have a double maxima rainfall regime. The mean annual rainfall in the Dormaa East district ranges between 1250 mm and 1750 mm and the mean monthly temperatures vary between 23°C and 33°C. The Sunyani West district has mean annual rainfall average of 1250 mm to 1500 mm and mean monthly temperatures between 25.5°C to 26.5°C. Mean annual rainfall in the Nkoranza South Municipal ranges from 1000 mm to 1300 mm and mean monthly temperatures are from 26°C to 38°C. Agriculture is the main occupation in these locations (Ghana Statistical Service, 2014a; 2014b; 2014c). The climate in the Dormaa East and Sunyani West District is suitable for the cultivation of staple crops like cassava, cocoyam and plantain and tree crops such as cocoa, citrus and oil palm. In the Nkoranza Municipal staple crops cultivated include yam and cassava and tree crops such as cashew and mango.

Research Design

Both quantitative and qualitative study designs were used which comprised surveys and focus group discussions (FGD). The survey was used to enhance the external validity of the study and the FGD provided an understanding of the survey results.

Selection of respondents

Simple random sampling technique was used to select the villages within each study area and cassava farmers for the survey. Four villages were randomly selected from a list of villages with reported cases of cassava root rot disease in each district. Three to five cassava farmers were randomly selected from each village depending on the intensity of cassava farming in the village with the assistance of the local agricultural extension officer and the village leader. A total of fifty five (55) cassava farmers were selected; 15 from the Dormaa East District and 20 each from the Sunyani West District and Nkoranza South Municipal.

Participants for the FGD were selected from the villages where the surveys were conducted. Eight to twelve cassava farmers that did not take part in the survey

participated in each FGD session. The selected farmers had been in cassava cultivation for at least five years and were experienced in cassava farming.

Data Collection

Survey

Using a structured questionnaire, information was obtained from the farmers on (i) their knowledge of symptoms of the cassava root rot disease (ii) the observance of the disease in the field and period of occurrence and (iii) cultural practices (land preparation, cassava varieties grown, soil fertility maintenance and harvesting methods) employed in cassava production. A checklist of photographs showing the symptoms of the cassava root rot disease was used to guide the farmers in the identification of the disease.

Cassava fields belonging to the selected farmers were examined for symptoms of the cassava root rot disease. Thirty cassava plants were selected one metre apart along two diagonal transects across each field, uprooted and examined for symptoms of root rot disease. Percentage cassava root rot incidence (I) per farm was calculated using the formula described by Aigbe and Remison (2009), while percentage severity (S) per field was calculated using the formula described by Aigbe and Remison (2010).

$$\text{Percentage incidence (I)} = \frac{\text{Number of rotten roots}}{\text{Total number of roots examined}} \times 100$$

$$\text{Percentage severity per farm (S)} = \left(\frac{\text{Total percentages of rotten roots parts}}{\text{Number of roots} \times 100} \right) \times \frac{100}{1}$$

The percentage rotted area of roots was calculated by visual observation and by making longitudinal and cross sectional slices of the storage roots with rot. The percentage severity of rot of each storage root was placed in one of five categories: 0 = no rot; 1 = 1-10% root volume rotten; 2 = 11-25% root volume rotten; 3 = 26-50% root volume rotten; and 4 = >50% root volume rotten as described by Messiga *et al.*, (2004) modified by assigning a score rating to the categories.

Isolation and identification of fungi associated with cassava root rot

Cassava roots with rot symptoms were collected from each diseased farm for the detection of the associated pathogen in the laboratory. Small tissue pieces (approx. 5mm x 5 mm) of diseased samples collected from the fields were surface sterilized in 0.5% sodium hypochlorite solution and inoculated on to potato dextrose agar (PDA) medium amended with 0.03 % chloramphenicol and incubated at 26± 2°C for seven days. Pure cultures were obtained by sub culturing single strand hyphae on to other PDA plates. Pathogens associated with the disease were identified based on the colony morphology and microscopic examination of the fungal structures using the fungi identification manual compiled by Barnett and Hunter (1998). Pathogenicity tests were carried out to confirm the disease pathogens.

Focus group discussions (FGDs)

Two focus groups discussions were conducted in each district with cassava farmers. Open discussions were held with the FGD participants guided by an interview guide that focused on farmers' knowledge on symptoms of the cassava root rot disease and farming practices employed in cassava production.

Data Analyses

Data on mean incidence and severity score of cassava root rot disease in farms at the various locations were transformed using angular and square root transformation respectively for statistical comparison and analyzed using analysis of variance (ANOVA). Descriptive statistics (frequencies and percentages) was used to summarize the data on farmers' knowledge of the disease and cultural practices in cassava production. The software SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) was used in data analyses. Qualitative information from the FGD guided the interpretation of the survey results.

RESULTS AND DISCUSSION**Incidence and Severity of the cassava root rot disease**

Cassava root rot disease was observed at all the locations surveyed. The ANOVA showed significant differences between locations in incidence of cassava root disease $F(11, 44) = 15.28$; $p < 0.01$; $\eta^2 = .36$. The highest mean incidence was recorded was at Amanfe (34.7%) in the Forest but this was similar to that recorded at Wamfie (31.4%); Kwatire (31.2%); Kyeremasu (31.0%); Merefrewo (30.8%); Nsoatre (27.2%); Kwaso (24.6%); Asuakwaa (21.0%) the other locations surveyed in the Forest zone. However, the mean incidence of the disease at Amanfe was significantly higher than that recorded at Wagadudu (17%); Sessima (12%); Akuropong (4%) and Asempanaye (8.1) in the Transition zone (Table 1). These results suggest that mean disease incidence of the cassava root rot disease is higher in the Forest than in the Transition zone. In the Forest zone, favourable environmental conditions can enhance the development of the disease. Like other fungal pathogens, the higher rainfall and higher temperatures in the Forest zone created humid environmental conditions that might have enhanced the activities of the root rot pathogens and the development of the cassava root rot disease.

Table 1: Mean incidence and mean severity score of the cassava root rot disease recorded at the locations in the Forest and Transition zones of the Brong-Ahafo region

Agro-ecological zone	Location	Mean incidence (%)	Location	Mean severity score
Forest zone	Amanfe	34.7 a	Wamfie	4a
	Wamfie	31.4 ab	Amanfe	3ab
	Kwatire	31.2 ab	Kyeremaso	3ab
	Kyeremasu	31.0 ab	Merefrewo	3ab
	Merefrewo	30.8 abc	Asuakwaa	3ab
	Nsoatre	27.2 abc	Nsoatre	2abc
	Kwaasoa	24.6 abc	Kwatire	2abc
	Asuakwaa	21.0 abc	Kwaasoa	2abc
Transition zone	Wagadu	17.0 bcd	Akuropong	2abc
	Sessima	12.0cd	Sessima	1bc
	Asempanaye	8.1d	Wagadu	0.5cd
	Akuropong	4.0d	Asempanaye	0.5cd

Means in the same column bearing the same letters are not significantly different from each other ($P < 0.05$) according to Tukey test

Mean incidence recorded at Nsoatre (27.2%); Kwaasoa (24.6%); and Asuakwaa (21.0) were similar to that at Wagadugu (17.0%) and Sessima (12%) in the Transition zone (Table1). Similar environmental conditions in the relatively drier areas of the Forest zone where Nsoatre, Kwaasoa and Asuakwaa are situated and in Transition zone might have contributed to this effect (Ghana Statistical Service, 2014a; 2014b; 2014c). Reports indicate that the Forest and Transition zones do not have sharp boundaries; there is a gradual extension of climatic conditions between them (Oliveras and Malhi, 2016).

The ANOVA showed significant differences between locations in mean severity of cassava root disease $F(11, 44) = 5.60$; $p < 0.01$; $\eta^2 = 0.59$). The highest mean severity score of 4 was recorded at Wamfie; this was not significantly different from that at

Amanfe (3); Kyeremaso (3); Merefrewo (3); Asuokwaa (3); Nsoatre (2) Kwaasoa(2) and Kwatire (2) in the Forest zone; but was significantly higher than that at Sessima (1); Akuropong (0.5) and Asemapanaye (0.5) in the Transition zone. The higher mean severity of the cassava root rot disease recorded at most of the locations in the Forest zone could be attributed to better growing conditions for the root rot pathogens. This suggests when factors for full expression of disease are available disease severity is be high (Mark *et al.* (2006). Agrios (2005) reported that factors such as high rainfall, favourable temperature range, humidity, pH of soil and other soil available nutrients could positively affect the growth and development of fungal pathogens to cause infection. These conditions are relatively more favourable in the Forest than in the Transition zone. The presence of the noxious weed *Chromolaena odorata* observed in the cassava farms at Wamfie, Amanfe and Kyeremaso in the more humid areas of the Forest zone might have been a contributory factor. Research indicates that *Chromolaena odorata* serves as alternative host to the cassava root rot pathogens *Fusarium spp.* and *Lasiodiplodia theobromae* (Bandyopadhyay *et al.*, 2006). These calls for farm management practices that tend reduce the incidence and infestation of *Chromolaena odorata*.

Fungal pathogens associated with cassava root rot disease

Lasiodiplodia theobromae and *Fusarium* species were consistently isolated from the rotten cassava samples collected from the cassava fields. Pathogenicity tests confirmed that both fungi were pathogenic to cassava root. Earlier studies by Onyenka *et al.* (2002) and Msikita, *et al.*, (1997) had identified *L. theobromae* and *Fusarium spp* as important pathogens of cassava root rot in Nigeria, Benin and Cameroon. In this study, more than 70% of the 34 fungal isolates obtained from the Forest zone and over 60% of the 14 isolates obtained from the Transition zone were identified as *Lasiodiplodia theobromae* (Table 2). These findings suggest that *Lasiodiplodia theobromae* is the predominant cassava root rot pathogen in the Brong Ahafo region.

Table 2: Frequency of fungal isolates obtained from infected samples collected from cassava farms

Agro- ecozone	Fungal isolates				Total
	<i>Lasiodiplodia theobromae</i>		<i>Fusarium spp</i>		
	Frequency	Percentage (%)	Frequency.	Percentage (%)	
Forest	25	73.5	9	26.5	34
Transition	9	64.3	5	35.7	14

Respondents' knowledge on cassava root rot disease

All the respondents interviewed were aware of the cassava root rot disease and had observed the rotten cassava root symptoms in their farms (Table 3). About 75% of the respondents reported that the disease occurred throughout the year but it was more prevalent in the rainy season (Table 3). This finding corroborates earlier

reports by Msikita *et al.*, (2005) and Mwangi *et al.*, (2004) that cassava root rot diseases occur throughout the year but increase movement of the root rot pathogens in the soil to new areas in the rainy season due to the availability of water in the soil leads to high prevalence of cassava root rot disease in the rainy season. Delayed harvesting of matured storage roots, planting in waterlogged soils and maintaining high weed density in cassava farms were reported to be the causes of cassava root rot disease by 71%, 25.5% and 3.6% of the respondents (Table 3). These assertions are consistent with previous reports by Waller (1986), Chikoye *et al.* (2000), Onyeka (2002), Bandyopadhyay *et al.* (2006) and Afolabi *et al.* (2011). These findings suggest that the farmers have a fair knowledge of the cassava root rot disease.

Table 3: Respondents' knowledge on the cassava root rot disease

Description	Frequency	Percentage (%)
Aware of CRRD	55	100
Have observed CRRD symptoms in cassava field	55	100
<i>Time CRRD was observed</i>		
All year	43	78.2
Rainy season only	12	21.8
<i>Causes of CRRD</i>		
Delayed harvesting	39	71
Planting in waterlogged soils	14	25.5
High weed density	2	3.6

Cassava was cultivated in mixed cropping, intercropping and sole cropping systems. About 33% of the respondents cultivated cassava together with tree crops such as cocoa, oil palm and citrus and staples such as cocoyam and plantain continuously until a complete canopy is formed by the tree crop. Intercrops such as cocoa and cocoyam could serve as alternate host to the root rot pathogen (Twumasi *et al.*, 2014). More than 40% of the respondents had intercropped cassava with maize or yam without a fallow period for a period not less than three years. Consequently more than 70% of the respondents had cultivated cassava consecutively on the same field for at least three years (Fig. 3). Meanwhile only 9.1% of the respondents intercropped cassava with groundnut to improve the fertility of the soil while none

of respondents applied chemical fertilizer in cassava cultivation (Fig. 3). Apparently the respondents perceived that chemical fertilizer could induce storage root rot or affect the sticky texture of boiled cassava. This assertion is consistent with the findings of Tetteh and Frimpong (1991) that most farmers have the opinion that cassava root tubers rot and the food quality of cassava is reduced when chemical fertilizers are applied in cassava cultivation. Cultivating the same piece of land continuously without soil fertility improvement could lead to soils with low fertility. Planting cassava in such infertile soils can affect plant growth and produce weak cassava plants that can easily succumb to diseases. Cong-Doan and Deturk (1998) compared the effect of long-term cultivation of cassava with that of natural forest, rubber, cashew and sugarcane grown on similar soils and observed that cassava cultivation resulted in the lowest levels of soil organic carbon, total nitrogen and exchangeable potassium and magnesium. Moreover the continuous cultivation of cassava on the same field is likely to lead to a buildup of pathogen population in the soil (Entwistle, 1990). Moses *et al.* (2005) cautioned that cultivation of cassava crop consecutively for three years on the same field could lead to a build-up of root rot pathogens in the soil. Though the respondents were aware of the consequences of continuous cropping of cassava on the same piece of land, their efforts to obtain new fields were often thwarted by the land tenure system.

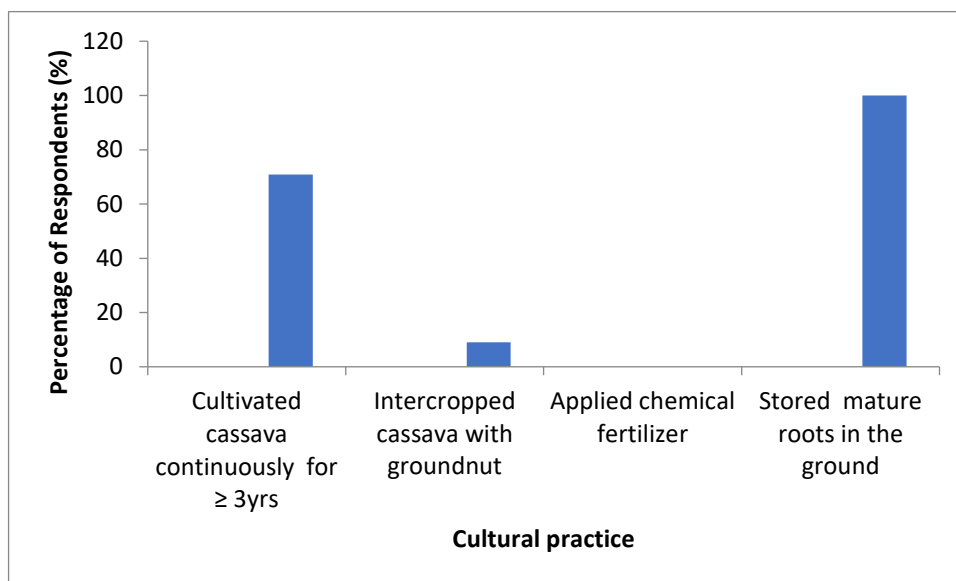


Fig 1. Cultural practices by the Respondents

All the respondents retained mature storage roots in the ground for prolonged periods and harvested them gradually as needed (Fig. 1). Discussions with the farmers and observations in the field indicated that piecemeal harvesting of mature cassava roots was preferred; the entire mature crop was harvested only when the produce was meant for sale in bulk. Consequently delayed harvesting resulted in large quantities of the cassava roots lost to root rot. This is consistent with Onyeka (2002) who observed significant increases in rot intensity when cassava plants were left in the field for up to 15 months after planting in Nigeria. Rotten cassava roots were found

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scattered on 54.5% of the farms surveyed; and this indicated poor farm sanitation. The discarded crop debris could serve as source of inoculum for subsequent cassava plantings and enhance the cassava root rot disease (Entwistle, 1990).

CONCLUSION

The results from this study indicate that the incidence and severity of the cassava root rot disease prevalent in the Brong Ahafo region of Ghana is higher in the Forest zone than in the Transition zone. *Lasiodiplodia theobromae* is the predominant cassava root rot pathogen. Farmers have a fair knowledge of the cassava root rot disease but they lack disease control methods. This requires farmer education the identification and the management of the cassava root rot disease. Unfavorable environmental conditions and poor farm management practices contribute to cassava root rot disease. Farmers need to select well drained sites that do not retain water for cultivation, adopt soil fertility improvement measures and harvest matured cassava storage roots promptly to effectively control the cassava root rot disease.

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