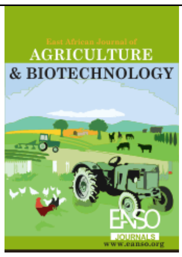

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Original Article

Cassava Brown Streak Disease Prevalence in Smallholder Cassava Cropping Systems in Northern Uganda: The Case of Acholi Sub-region

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ABSTRACT

Cassava brown streak disease (CBSD) is a devastating disease of cassava in Uganda. Limited information exists on the incidence and severity of CBSD in Northern Uganda. The prevalence of CBSD in the eight (8) districts in the Acholi sub-region is also unknown. Therefore, the current study intended to: a) determine the prevalence and severity of CBSD in the Acholi sub-region, and b) identify the drivers of CBSD epidemics in smallholder cassava cropping systems in Acholi. An assessment of 120 cassava fields was conducted in the 2018b season. CBSD field incidence was highest in Nwoya District (51.3%) and lowest in Kitgum (6.4%), with severity ranging from 2.1 to 3.4 in the sub-region. CBSD prevalence was also highest in Nwoya (76.2%) and lowest in Kitgum and Pader Districts (30.8%). The use of CBSD-susceptible varieties (TME 14, TME 204, and NASE 12) was identified as the main driver of the epidemic. The result of the current study highlights the need for a wide-scale CBSD awareness creation and community-based cassava seed multiplication and distribution system in the Acholi sub-region to promote the up-take of CBSD-tolerant cassava varieties.

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INTRODUCTION

Cassava is a very important staple crop in Uganda. The productivity of cassava in Uganda is constrained by a number of pests and diseases, with Cassava brown streak disease (CBSD) as the most devastating (Alicai et al., 2019). The disease is caused by cassava brown streak virus (CBSV) and Ugandan cassava brown streak virus, (UCBSV) (Monger et al., 2001). According to Maruthi et al. (2017), both viruses are transmitted by an insect vector, *Bemisia tabaci* (whitefly), and by human-mediated vegetative propagation of infected planting stems.

CBSD symptoms vary depending on cultivar, crop age, and weather conditions (Hillocks et al., 2002). The disease affects the yield and quality of the tuberous roots of cassava. Symptom on the tuberous roots occurs as a yellow or brown, corky necrosis in the starch-bearing tissues (Hillocks and Jennings, 2003). The necrosis is reported to begin as discrete areas, affecting most of the roots in fully susceptible cultivars, making the roots unmarketable and entirely inedible in the most susceptible varieties (Hillocks et al., 2002; Alicai et al., 2007).

A major outbreak of CBSD in Uganda was recorded in 2004 near Kampala (Alicai et al., 2007). In the following years, CBSD outbreaks were noted across the eastern, central, and northern parts of the country (Alicai et al., 2019). CBSD poses a threat to all cassava-growing regions including northern Uganda. CBSD's re-emergence in the country created the need for breeding for resistance as an effective management option. Subsequently, CBSD-tolerant varieties were released and deployed in cassava-growing areas in Uganda, including Northern Uganda.

Annual field survey data from 2004 to 2017 (Alicai et al. 2019) revealed an increase in CBSD prevalence in Acholi Sub-region. However, not much is known about the current CBSD epidemic in the sub-region. Knowledge of disease epidemics is important in disease management. The present survey was conducted to study CBSD field incidence, prevalence, and severity in the Acholi Sub-region of Uganda.

METHOD

CBSD Survey in Eight (8) Districts

A total of 120 farmers’ fields of cassava in Nwoya, Amuru, Omoro, and Gulu (West Acholi), and Agago, Pader, Kitgum, and Lamwo (East Acholi) districts, were assessed in December 2018 to record the incidence and severity of CBSD. Fifteen (15) small-scale cassava fields (< 1.0 acre) in each district were assessed for above-ground symptoms and 10 fields for symptoms on roots. Fields were selected at regular intervals along major and feeder roads traversing the districts. The distance between the fields sampled was 8-10 km for above-ground symptoms and 20 km for symptoms on tuberous roots. Crops assessed for foliar symptoms were those planted 3 to 6 months previously. Crops more than 10 months old were assessed for symptoms on tuberous roots.

For above-ground symptoms, 30 plants were examined in detail within each field. The presence or absence of CBSD symptoms on the leaves was recorded for each plant using a scale described by Gondwe et al. (2003) and Alicai et al. (2007), where 1 (no symptoms) to 5 (defoliation). 10 plants were uprooted in fields sampled for tuberous root symptoms, and the tuberous roots were transversely sliced to check for root necrosis. Root symptoms were scored on a scale of 1 (no necrosis) to 5 (>25% necrotic) (Gondwe et al., 2003). The incidence of CBSD was calculated from the number of plants exhibiting CBSD (foliar) symptoms as a percentage of the total number of plants assessed in a field. In calculating mean severity per field, scores for symptomless plants were omitted.

Data Analysis

Data on mean field incidence, CBSD prevalence and mean tuberous root severity were analysed by analysis of variance (ANOVA) assuming a normal distribution. Data analysis was performed using the GENSTAT statistical package 16th

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edition. The data were subjected to ANOVA, and means were compared by Turkey's test.

RESULTS

Incidences and Severities of CBSD

The result of the survey of CBSD in Acholi sub-region is presented in *Table 1*. Mean field incidence was significantly (P≤0.05) higher in Nwoya District (51.3%). Overall, the mean field incidence was higher in West Acholi (Nwoya-51.3%, Amuru-23.8%, Omoru-26.9%, and Gulu-26.9%) than in East Acholi (Pader-14.4%, Kitgum-6.7%, Lamwo-10%, and Agago-21.2%). A similar trend was recorded for CBSD prevalence. A significantly higher CBSD prevalence (P≤0.05) was recorded in West Acholi (Nwoya-76.2%, Omoro-66.7%, Amuru-60% and Gulu-47.1%). The highest and lowest CBSD prevalence in East Acholi was recorded in Lamwo (40%) and Agago-35.3%, respectively. The mean tuberous root severity was significant (P≤0.05). The highest mean tuberous root severity was recorded in West Acholi (Nwoya-3.4) and the lowest in East Acholi (Lamwo-2.1 and Agago-2.1) (*Figure 1*).

Table 1: Incidence and severity of cassava brown streak disease (CBSD in farmers` fields in Acholi sub-region of Uganda

Acholi sub-region	Districts	Mean field incidence (%)	CBSD Prevalence (%)	Mean tuberous root severity (1-5)
East Acholi	Kitgum	6.7e	30.8d	2.3c
	Lamwo	10.0de	40.0cd	2.1c
	Pader	14.4d	30.8d	2.4c
	Agago	21.2c	35.3d	2.1c
	Mean	13.1d	34.2d	2.2c
West Acholi	Nwoya	51.3a	76.2a	3.4a
	Amuru	23.8c	60.0b	2.9b
	Omoro	26.9bc	66.7b	2.7bc
	Gulu	26.9bc	47.1c	3.2ab
	Mean	32.2b	62.5b	3.1ab
	CV (%)	11.8	8.4	7.4
	LSD (5%)	5.22	7.56	0.41

Means within the same column followed by the same letter are not significantly different at 5% significance level

On average, field incidence and CBSD prevalence were higher in West Acholi (32.2%, 62.5%, respectively) when compared to East Acholi where field incidence and CBSD prevalence were 13.1% and 34.2%, respectively (*Figure 1*).

The result of the assessment of the prevalence of improved cassava varieties being grown by farmers in the eight districts is presented in *Figure 2*. A total of 5 improved cassava varieties were being grown, 3 CBSD susceptible varieties (TME204, TME 14, NASE12) and 2 CBSD tolerant varieties (NAROCAS1 and NASE14). CBSD susceptible varieties occurred more frequently (88.9%) than CBSD tolerant varieties (11.01%). Of the 5 varieties, CBSD susceptible variety TME14 was the most common variety in all eight districts (Kitgum-100%, Lamwo-100%, Pader-84.6%, Agago-70.6, Nwoya-85.7%, Amuru-95%, Omoro-81.3% & Gulu-94.1%). TME204 was recorded only in Pader (7.7%) and Agago (17.6%), NASE12 in Nwoya (14.3%) and Agago (5.9%). CBSD tolerant NAROCAS1 was found only in Gulu (2.7%) and Omoro (2.5%), and NASE14 in Amuru (5%), Omoro (6.5%), Gulu (5.9%), Agago (5.9%) and Pader (7.7%). Among the susceptible varieties, the highest mean tuberous root severity was recorded on NASE12, followed by TME204. TME14 exhibited the lost mean tuberous root sevirty.

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Figure 1: Average CBSD field incidence and CBSD prevalence recorded in Acholi Sub-region in 2018

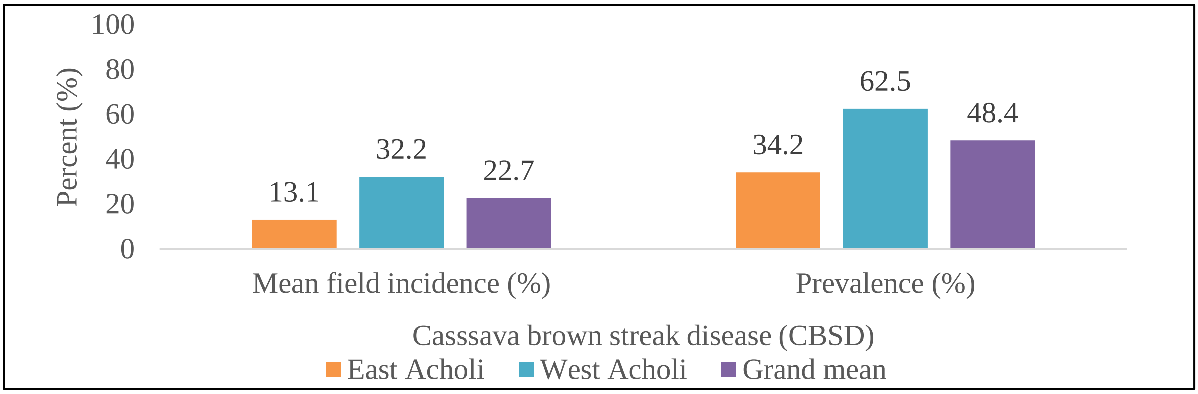
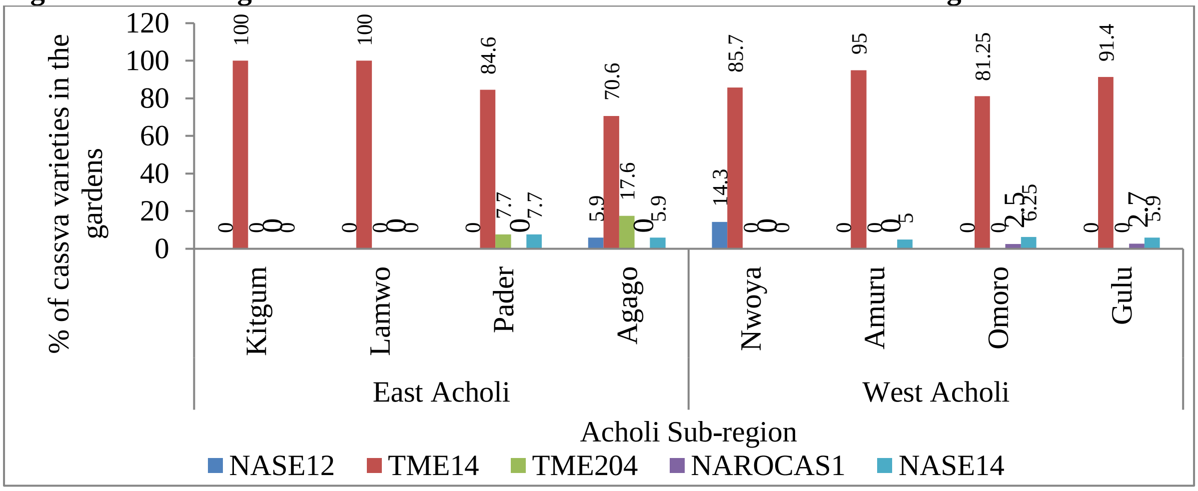


Figure 2: Percentage of cassava varieties in farmers` fields in Acholi Sub-region in 2018



DISCUSSION

CBSD field indicator survey in Acholi showed that CBSD poses a greater threat to cassava production in the sub-region. There are a number of reasons for the current high prevalence of CBSD in West Acholi. The disease might have been present in a few gardens planted with CBSD susceptible varieties like TME14, TME204, and NASE12 for some years at a low level and were not identified and managed. It is also a known fact that farmers in Northern Uganda share cassava planting materials. The sharing of cassava cuttings from CBSD-affected gardens among relatives and friends could have been responsible for the very high CBSD field incidence and prevalence in West Acholi. The degeneration of CBSD susceptible genotypes due to increased vial lead resulting from years of recycling was reported in Nigerial (Shirima et al. 2019). The relatively low CBSD incidence and prevalence in East Acholi could be due to the fact that most of the planting materials (TME14, TME204, and NASE12) being recycled are from CBSD-free gardens.

It is also possible that there could have been an introduction of infected panting materials from other parts of the country including the eastern and central areas of Uganda where CBSD is endemic. This point seems rational to the extent that, in the current study, a number of farmers reported the source of the TME14 planting materials being recycled in their communities as having been supplied from outside the sub-region. Thus, it is possible that the CBSD-susceptible planting materials distributed to farmers in previous years, which are now being recycled, were diseased. According to Chikoti and Tembo (2021), the wide spread of CBSD in East and Central Africa was as a result of the use of infected planting materials transported across long distances. This observation was in agreement with the findings of surveys conducted in DRC

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between 2015 and 2018 where CBSD was found to be present in Sud-Kivu and Haut-Kantanga provinces, but not in a province that is situated between the two provinces (Casinga et al., 2021).

It is however, surprising that despite the effort of government in the recent years to support smallholder farmers with planting materials of CBSD-tolerant cassava, CBSD-susceptible improved cassava varieties occurred more frequently (88.9%) than CBSD-tolerant varieties (11.01%). The low frequency of occurrence of improved CBSD-tolerant varieties (NAROCASS 1, NASE 14, and NASE 19) in the eight districts suggests there is a low rate of adoption probably because of the late distribution of planting materials to farmers. By the time materials are distributed, farmers will have planted home-saved seeds of the earlier adopted CBSD susceptible varieties (TME 14, TME 204, and NASE 13).

CBSD induces root necrosis, causing yield losses up to 70%-100%. The necrosis makes the tuberous roots not only unmarketable but also inedible especially in the most susceptible varieties (Hillocks et al. 2001; Alicai et al. 2007). Since farmers in Acholi are widely growing susceptible varieties, yield losses due to CBSD threaten household food security. The disease poses a major threat to cassava production in northern Uganda. As a result of the destruction caused by CBSD, it is critical to understand the drivers of the CBSD epidemic in Acholi order to predict the extent of human-mediated spread, and to identify appropriate control strategies.

CONCLUSION AND RECOMMENDATIONS

The high prevalence of CBSD in the Acholi sub-region raises concern for food production and household income in the country. As observed in the current study, farmers in the sub-region region predominantly grow the earlier introduced CMD tolerant varieties, which already commonly suffer from CBSD, resulting in high yield penalty. There is, therefore, an urgent need for enforcement of phytosanitary and regulatory measures at district levels to restrict the further spread of CBSD within the sub-region. Furthermore, the high prevalence of CBSD in West Acholi has implications for the movement of cassava planting materials within the sub-region. Specifically, it is important that the practice of movement of cassava planting materials between districts through the open quarantine system is revised to promote the exchange of diseased free materials from fields inspected by extension staff at sub-counties. This will require training of extension workers on the above and below-ground symptoms of CBSD, field inspection techniques, and identification of CBSD tolerant varieties. But for long-term and sustainable control, deployment of cultivars with resistance to CBSD should be prioritized in the sub-region.

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