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Cassava Pests and Diseases' Prevalence and Performance as Revealed by Adaptive Trial Sites in North Western Agro-Ecological Zone of Uganda

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Abstract

Cassava adaptive trial was planted in ten sub counties across West Nile Agro-ecological Zone (WNAEZ) with six cassava varieties to test their performance and reactions to major pests and diseases present in the Zone. Th six cassava varieties comprised of improved (TME 14 and 204, NASE 13 and 14 and Akena – TMS I92/00067) and a local (Abiria) were selected based on their availability and preference in the region. The experiment was planted in RCBD design with three replicates. The experiment was planted in ten locations with the plot size was 6x6 metres. Results showed Cassava green mite (CGM), Cassava mosaic disease (CMD) and cassava bacterial blight (CBB) as major pest and diseases across all sites. Cassava Anthracnose (CA) and Cassava mealy bug (CM) were not present in the study sites. Cassava brown streak disease (CBSD) foliar symptoms was observed in three locations of Dranya s/c, Gimara s/c and Nyaravuru s/c on the three varieties of TME 204, TMS-I92/00067 and TME 14, whereas CBSD root necrosis was seen across all sites on TME 204, TMS-I92/00067, NASE 13, TME 14 and the Local except on NASE 14. In terms of yields, results showed that it was highest in TMS-I92/00067 (53.0 t/ha), TME 204 (46.0 t/ha), NASE 14 (39.4 t/ha), TME 14 (34.6 t/ha), NASE 13 (33.4 t/ha) and the local (22.7 t/ha) in that order. Farmers' ranking of the studied cassava varieties in order of preference was in the order of NASE 14, TME 204, TMS-I92/00067, TME 14, NASE 13 and the Local. In conclusion, absence of both foliar and root symptoms on NASE 14 across all sites indicated that this variety is still tolerant to CBSD and can still be multiplied for production in West Nile Agro-ecological Zone.

Keywords: prevalence, reactions, performance, root necrosis, preference, ranking

1. Introduction

Cassava (*Manihot esculenta* Crantz) is cultivated throughout the lowland tropics, typically between 30°N and 30°S of the equator, in areas where the annual mean temperature is greater than 18^0C (Nasser & Ortiz, 2007). Cassava is an important crop in Africa where it serves as a famine reserve crop, industrial raw material and livestock feed (Nkweke et al., 2002). The crop stores well in the soil, has high starch productivity and performs relatively well in low fertility soils and marginal areas (Hershey, 2010). The diverse uses of cassava largely explain its popularity in the tropics (Hershey, 2010). In Africa most cassava produced is used for food consumption, with 50% in processed form, and 38% in the fresh and/ or boil form; 12% is used for animal feed. Ugwu and Ay (1992) noted that in Africa, there are five common groups of cassava products: fresh root, dried roots, pasty products, granulated products and cassava leaves. Cassava yields vary with cultivars, season of planting, soil type and fertility (IFAD & FAO, 2000) as well as with the level of infestation and infection with pests and diseases respectively (Bock, 2004). In Uganda, cassava is the second most important food crop after bananas (Semakula et al., 2004) and in Westnile region it ranks as the most priority crop (NARO Report, 2004). However, many pathogens and pests reduce cassava yields, especially in Africa (Dixon et al., 2003; Oerke, 2006) including Uganda. Diseases such as cassava mosaic disease (CMD), transmitted by a whitefly (*Bemisia tabaci*) vector and spread by infected cuttings, cassava brown streak virus disease (CBSD), Cassava bacterial blight (*Xanthomonas axonopodis* pv. *manihotis*) (CBB), and anthracnose (*Colletotrichum gloeosporoides*) (CA) are among the most important diseases. Pests with a wide African spread are the cassava mealybug (*Phenacoccus manihoti*) (CM), African root and tuber scale (*Stictococcus vayssierei*), cassava green mite (*Mononychellus tanajoa*) (CGM) and nematodes (particularly *Meloidogyne spp*.). Therefore, in this study the

main objective was to test for the prevalence of major cassava pests and diseases and subject some of the elite cassava varieties to on-farm farmers' evaluation to test their acceptability in North Western Agro-ecological zone through adaptive trials.

1.1 Materials and Methods

1.1.1 Cassava Varieties Evaluated

Six cassava varieties of symptomless plants that comprised of five improved (NASE 13, NASE 14, TMS I92/00067, TME 14, and TME 204) and a local variety "Abiria" were used. The varieties NASE 13, TMS I92/00067 and TME 14 are among the commonly grown varieties in this region, NASE 14 is a newly released cassava variety that is tolerant to CBSD and TME 204 is a very susceptible variety to CBSD. The local cassava variety "Abiria" was used to compare the responses between improved and landraces across this region.

1.1.2 Experimental Sites and Design

Ten adaptive trial sites were planted in five out of eight different districts of North Western region of Uganda during the first rains of April 2012. The ten sites were in Manibe sub county in Arua district, Kijomoro and Yivu sub counties in Maracha district, Abuku and Dranya sub counties in Koboko district, Gimara and Moyo sub counties in Moyo district, Nyaravuru sub County in Nebbi district and Abanga and Jangu-okoro sub counties in Zombo district. These sites differ in altitude, soil texture, mean annual temperature and rainfall and cultural practices. The plot sizes were six by six meters, in a randomized complete block design (RCBD) with three replicates in every site using a spacing of one by one meter. The site in Jangu-okoro was affected by hailstones and thus its results could not be considered for analysis. Weeding was done mechanically using hand hoes and no fertilizer and or herbicide was applied.

1.2 Data Collection and Analysis

The established cassava varieties were evaluated at 4, 8, and 12 months planting (MAP) for CBSD foliar symptoms, CMD, CBB, CGM, CA, CM and whitefly infestation. CBSD root severity and incidence for CBSD were evaluated at 12 MAP at harvest. Plants were assigned disease severity scores based on the standard five point scoring scale for CBSD (Gondwe et al, 2003), where 1 = no apparent symptoms, 2 = slight foliar feathery chlorosis, no stem lesions, 3 = pronounced foliar feathery chlorosis, mild stem lesions, and no die back, 4 = severe foliar feathery chlorosis, severe stem lesions, and no die back, and 5 = defoliation, severe stem lesions and die back. Root symptoms assessment was done using a scale of 1-5 (Gondwe et al, 2003), where 1 = no apparent necrosis, 2 = less than 5% of root necrotic, 3 = 5-10% of root necrotic, 4 = 10-25% of root necrotic, mild root constriction and 5 = >25% of root necrotic with severe root constriction. For CMD the scales used were, 1 = Un-affected shoots, or no symptoms observed, 2 = Mild chlorotic pattern on most leaves, mild distortions at the bases of most leaves, while the remaining parts of the leaves and leaflets appear green and healthy, 3 = Pronounced mosaic pattern on most leaves, narrowing and distortion of the lower one- third of the leaves, 4 = Severe mosaic distortion of two-thirds of most leaves and general reduction of leaf size, and some stunting of shoots, and 5 = Very severe mosaic symptoms on all leaves, distortion, twisting and severe leaf reduction of most leaves accompanied by severe stunting of plants (IITA, 1990).

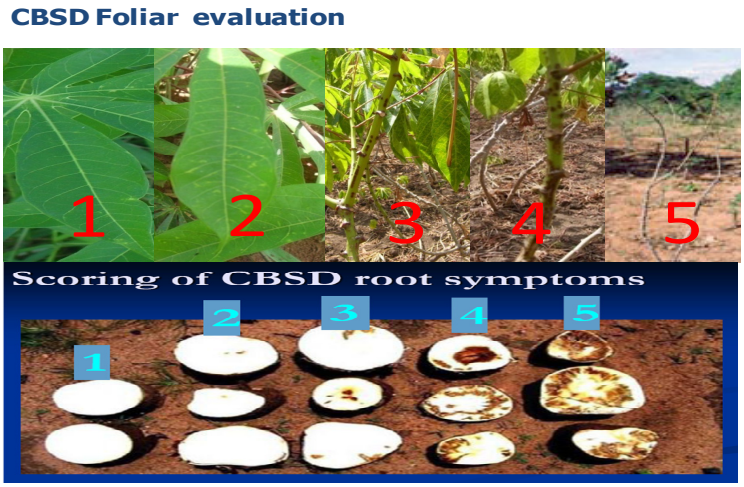

Figure 1. Foliar and root scoring scales; Root scales adapted from IITA, 1990

At harvest, two agronomic traits harvest indices (HI) and root dry matter content (DMC) were computed as described by Abaca et al. (2012b). The disease incidence and severity, DMC and HI data were subjected to analysis of variance (ANOVA) to establish whether or not significant difference exists among cassava genotypes. All this analysis was done Genstat, 13th Edition computer Package (Goedhart & Thissen, 2010).

3. Results

Results showed that significant differences exist among the cassava varieties and locations, diseases and pests incidences and severities ($p<0.001$). Table 1 below shows the average pests and diseases foliar incidence (Inc) and severity (Sev) accessed through scoring over the study period. Cassava green mite was highest in NASE 13 (67%, 2.1) and lowest in the local (38.9%, 2.0), cassava mosaic disease was highest in the Local (82.5%, 3.4) and not present on NASE 14 (0%, 1), Foliar CBSD was highest in TME 204 (22.5%, 2.0) and not present on NASE 14, NASE 13 and Local (0%, 1), cassava bacterial blight was highest in TME 14 (100%, 2.3) and lowest on NASE 14 (73.8%, 2.0), cassava anthracnose and cassava mealybug were not observed across all study sites.

In terms of locations (Figure 1), Foliar CBSD with the highest incidence of 23.1 percent was observed at Gimara sub-county in Moyo with a severity score of 2.3 and not present at Abanga, Abuku, Kijomoro, Moyo and Yivu sub-counties, CMD was highest at Gimara and Yivu sub-counties (100 percent) with a severity of 3.1 and lowest at Abanga (37 percent) with a severity score of 2.3, CBB was highest at Abuku and Kijomoro sub-counties (100 percent) with severity score of 2.7 and lowest at Abanga (72 percent) though with the highest severity score of 3.6, and CGM was highest at Nyaravuru (92.5 percent) with severity of 2.5 and lowest at Kijomoro (15.5 percent) with a severity score of 1.3.

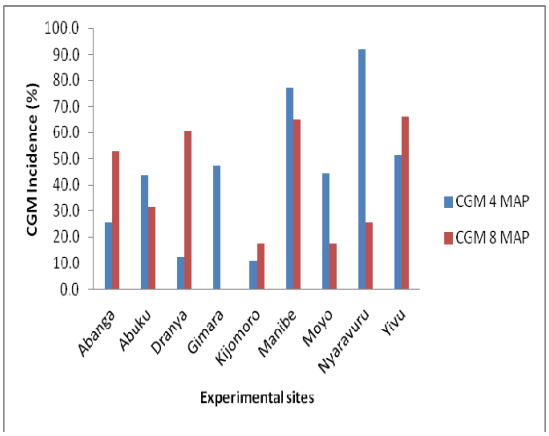

Figure 1A. Presence of CGM at different locations

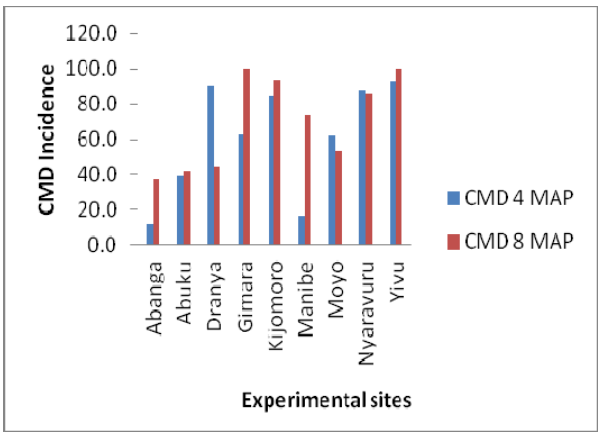

Figure 1B. Presence of CMD at different locations

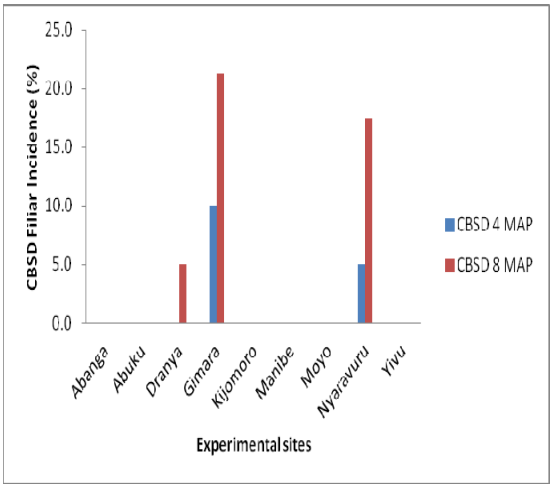

Figure 1C. Presence of CBSD at different locations

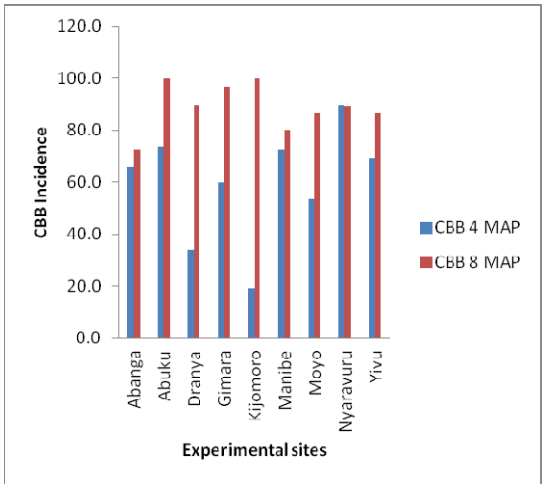

Figure 1 D. Presence of CBB at different locations

Figure 1. Presence of foliar symptoms for pests and diseases at different locations within the West Nile Agro-ecological Zone at 4 and 8 MAP

Table 1. Mean foliar incidence (Inc) and Severity (Sev) for cassava green mites (CGM), cassava mosaic disease (CMD), cassava brown streak disease (CBSD), cassava bacterial blight disease (CBB), cassava anthracnose (CA) and cassava mealy bug (CM) across sites in West Nile Agro-ecological Zone during April 2012 to April 2013 seasons

VARIETY	CGM		CMD		CBSD foliar		CBB		CA		CM	
	Inc	Sev	Inc	Sev	Inc	Sev	Inc	Sev	Inc	Sev	Inc	Sev
TME 204	64.1	2.2	15.0	2.0	22.5	2.0	97.3	3.4	0.0	1.0	0.0	1.0
TME 14	44.8	2.0	30.0	2.2	5.0	2.0	100.0	2.3	0.0	1.0	0.0	1.0
TMS I92/00067	48.3	2.0	23.3	2.3	17.5	2.5	97.6	2.5	0.0	1.0	0.0	1.0
NASE 13	67.0	2.1	42.0	2.0	0.0	1.0	86.0	2.2	0.0	1.0	0.0	1.0
NASE 14	40.0	2.0	0.0	1.0	0.0	1.0	73.8	2.0	0.0	1.0	0.0	1.0
LOCAL	38.9	2.0	82.5	3.4	0.0	1.0	81.7	2.1	0.0	1.0	0.0	1.0
Mean	50.52	2.05	32.13	2.15	7.50	11.58	89.40	2.42	0.0	1.0	0.0	1.0
CV (%)	24.07	4.08	88.49	35.76	133.33	41.97	11.8	21.17	-	0.0	-	0.0

Table 2 shows that, at harvest (12 MAP), CBSD root necrosis was highest on TMS I92/00067 (21.7%, 2.1), NASE 13 (14%, 2.0), TME 204 (15%, 3.0), TME 14 (10%, 2.0), Local (5.0%, 2.0) and was not observed on NASE 14 (0.0%, 1.0). Highest yields were observed on TMS-I92/00067 (53.0 t/ha), TME 204 (46.0 t/ha), NASE 14 (39.4 t/ha), TME 14 (34.6 t/ha), NASE 13 (33.4 t/ha) and the local (22.7 t/ha) in that order. The harvest index also follow this same order of yields that is, highest in TMS I92/00067 (0.64) and lowest in the local (0.48). Plant height was highest with NASE 13 (166.1 cm) and lowest in NASE 14 (133.8 cm). There was no much difference observed in terms of average number of roots per plant ranging from 7-9, whereas much difference was observed in root weight per plant, highest in TMS I92/00067 (5.3 kg) and lowest in the local (3.1 kg).

Table 2. Mean CBSD root Incidence and severity, Plant height, Number and Weight of roots per plant, yields, harvest index and farmers' ranking of the cassava varieties studied.

VARIETY	Average no. of roots/plant	Average root weight/plant (kg)	CBSD root		Yield (t/ha)	HI	Plant height (cm)	Farmers' Ranking of the varieties
			Inc	Sev				
NASE 13	8	3.7	14.0	2.0	36.7	0.54	166.1	5
NASE 14	9	3.9	0	1	39.4	0.60	133.8	1
TME 14	7	3.5	10	2	34.6	0.55	141.7	4
TME 204	9	4.6	15	3	46.0	0.63	160.2	2
TMS I92/00067	9	5.3	21.7	2.1	53.0	0.64	161.8	3
LOCAL	8	3.1	5.0	2.0	30.7	0.48	150.7	6
Mean	8.33	4.02	10.95	2.02	40.07	0.57	152.38	
CV (%)	9.8	19.94	70.44	31.43	20.33	10.68	8.30	

Table 3 below shows the mean CBSD root incidence and severity, plant height, number and weight of roots per plant, yields and harvest index of the cassava varieties studied by different locations. CBSD root necrosis was observed in almost all sites except Yivu sub county, though it was highest in Dranya sub county (16.7%, 2.0) and lowest in Manibe and Kijomoro sub counties (5%, 2.0 and 5%, 3.0 respectively). In terms of yields, it was highest in Abuku sub county (65.3 t/ha) and lowest in Moyo sub county (21.9 t/ha). Average weight per plant also followed this same trend, highest in Abuku sub county (6.5 kg) and lowest in Moyo sub county (2.2 kg).

Table 3. Mean CBSD root Incidence and severity, Plant height, Number and Weight of roots per plant, yields and harvest index of the cassava varieties studied by different locations

LOCATION	Average no. of roots/plant	Average weight/plant (kg)	CBSD root		Yield (t/ha)	HI	Plant height (cm)
			Inc	Sev			
Abanga	12	4.8	10.0	2.0	48.3	0.54	169.7
Abuku	11	6.5	10.0	2.0	65.3	0.58	185.1
Dranya	9	3.2	16.7	2.0	32.1	0.56	143.8
Gimara	7	5.6	13.8	2.5	55.9	0.56	172.2
Kijomoro	7	3.1	5.0	3.0	29.6	0.52	158.1
Manibe	8	4.0	5.0	2.0	40.1	0.66	128.4
Moyo	5	2.2	14.0	2.0	21.9	0.56	129.1
Nyaravuru	11	5.2	12.5	2.3	52.0	0.60	172.5
Yivu	7	3.6	0.0	1.0	35.8	0.61	117.7
Mean	8.56	4.24	9.67	2.09	42.33	0.58	152.96
CV (%)	27.48	32.48	55.54	25.49	33.12	07.25	15.67

Plate 1A. A Farmer group in Yivu s/c excitedly poses for a group photo

Plate 1B. A farmer in Abuku s/c struggles with harvesting very big and long cassava roots

Plate 1C. Researchers collect yield data at Manibe s/c in Arua

Plate 1. Researchers and Farmers actively participating during on-farm cassava evaluation across the different sites in West Nile region of Uganda

4. Discussion

The main purpose of this adaptive trial was to establish the reactions to major pests and diseases and other performance by the different cassava varieties that were evaluated. Foliar results indicate the Presence of cassava brown streak disease on TME 204, TME 14 and TMS - I92/00067(Akena). This is true as these varieties were bred only for CMD and not CBSD resistance. This supports the finding of Abaca et al., 2012b, when only five cassava varieties were found tolerant to CBSD, amongst which was NASE 14. However, lack of CBSD foliar symptom on the local does not mean that cassava brown streak viruses (CBSV) could be absent in this variety. This confirms problems associated with phenotypic evaluation that was pointed out by Abaca et al., 2012b, that the severe presence of CMD on a cassava plant tend to mask the symptom of CBSD. It's only under rare circumstance that dual symptoms of both CMD and CBSD can be seen clearly. While the presence of CBSD in Gimara in Moyo and Nyaravuru in Nebbi districts support the earlier idea that CBSD is a disease of lowland areas (Alicai et al., 2007; Abaca et al., 2012a) since these areas are located along the river Nile lowland belt. In addition, the wider distribution of CBSD in these areas can be attributed to a slightly higher number of whiteflies in these areas compared to other areas of WNAEZ. CBSD root necrosis was observed in five varieties (TME 204, TMS-I92/00067, NASE 13, TME 14 and the Local) and was not observed on NASE 14 across all the study sites. The highest CBSD root necrosis severity was observed in TME 204, which confirms it high level of

susceptibility. This result confirms the tolerance of come cassava varieties to CBSD and can be used to manage the disease (Abaca et al., 2012a, 2012b).

The results further confirm that CMD is presents at all experimental sites and on all varieties except NASE 14. However, for TME 14 and 204, Akena and NASE 13, CMD had a severity score of 2 compared to the landrace that had a severity score of 3.4. This has a lot of implications on cassava production for WNAEZ as cassava farmers have to rely of research institutes for their improved varieties as source of cassava planting materials. This result further showed that there is an urgent need to sensitize cassava farmers that are engage in local cassava production that harbour CMD and has low yield per unit area. This is in agreement with the finding of Ekwe and Njoru, 2011 for cassava farmers of Nigeria.

CGM and CBB were also present on all cassava varieties at all experimental sites. However, it should be noted here that CGM effects was observed to be greatest during the dry period than the wet period. Skovgård *et al*. (1993) had a similar finding with the cassava green mites in Kenya, when both the root yield and dry matter of cassava was affected by cassava green mites. CBB was observed on all varieties with very high incidences (73.8-100%) and equally high severities (2.0-3.4). This confirms that CBB is still a serious disease of cassava in this region. Again for CBB, it was observed that the infection is common in, and frequently limited to young plant tissues in all varieties studied. This is similar to the findings of Lozano (1986).

Varying yields were observed on both locations and varieties. This could be attributed to soil types, varietal differences and management practices employed by the different farmer groups. Specifically low yield was observed in Moyo s/c due to poor field maintenance (field left in bush of weeds) and the soil type being clayish, compared to high yield in Abuku and Gimara s/counties where the fields were well managed (free of weeds) and the soil type being sandy. These variations in yields explain the need for proper site selection and management in cassava production. Farmers' ranking of cassava varieties was not based on yield alone but a combination of factors; CBSD root necrosis, root size and shape, taste and prior knowledge on milling qualities of some varieties, processing techniques required amongst others. This is also similar to the finding Githunguri et al. (2005). These factors partly explain why NASE 13 was ranked 5th as most farmers explained that it has poor milling quality, hence good for fresh boiled roots only.

In conclusion, presence of CBB and CGM in high incidences and severities across sites in WNAEZ implies the need for concerted efforts to manage them in order to maximize cassava production in this zone. Similarly, absence of both foliar and root symptoms on NASE 14 across all sites indicated that this variety is still tolerant to CBSD and can still be multiplied for production in WNAEZ. In addition, proper cassava field management is required to achieve a better cassava yields. Host plant tolerant/resistance should continuously be use to manage some of these major pests and diseases.

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