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Screening of Selected Improved Cassava Varieties for Bacterial Blight and Varietal Performance under Natural Environment in Ibadan, South-Western Nigeria

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Abstract:
Cassava production is bedeviled by a plethora of biotic constraints among which Bacterial Blight is of most economic important in most cassava growing regions of Sub-Saharan Africa and Asia. Deployment of improved resistant varieties by various research institutes have thus far brought the disease under control, but continuous monitoring remains imperative to forestall further outbreak. For this reason, field experiment was performed to specifically screen six improved cassava varieties for CBB incidence and severity under natural environment at the botany research farm, University of Ibadan, Ibadan, Nigeria. The experimental field was laid out in a Randomized Complete Block Design with four replications each. The plot size was 20m x 41m comprising ridges each measuring 10m with 1m interval. Parameters assessed were disease incidence, disease severity scores and varietal performance for each genotype. Results from statistical analysis of SAS 9.3 (SAS, 2010) revealed that all the varieties expressed moderate to resistant (2.25-1.75) reaction to CBB severity in the field. Pearson correlation coefficient also indicated a significant negative correlation between root yield and root weight. From the foregoing, the result implicitly showed that farmers could reduce the high incidence of CBB in their farms and increase their yield by replacing the local lines with the improved varieties. Government should also organize programs (such as seminars and talk shows) addressing cassava diseases to further enlighten farmers on the importance of adopting improved cassava cultivation

Keywords: *Cassava, screening, bacterial blight, disease, incidence, severity*

1. Introduction

Cassava is one of the most important food crops, ranking fourth in world production of all tropical crops. It is the most important of the tropical root crops, being the staple for over 500 million people in the developing countries (RTIP, 2004, Victor and Emmanuel, 2012) and constitutes the most economic source of starch (Daramola and Oanyinlusi, 2006). The starchy roots are valuable sources of energy and can be boiled or processed in different forms for human consumption (Chukwuka*et al*., 2013).The potential of cassava in improving the living standard on rural farmers has been documented (Omonona*et al.,* 2006; Kormawa et al; 2001; Dankyi and Adjekum, 2007). The peels are generated in the production of garri, akpu and starch (Akpomie et al; 2012). Cassava production in Nigeria plays a prominent role in alleviating poverty and hunger as it is virtually impossible that an average household will not consume cassava or its products in a day (Ayode, 2012).

(FAOSTAT, 2009) reported that African countries produce over 103 million metric tons cassava per annum with Nigeria accounting for approximately 35 million metric tons per annum. Moreover, Nigeria alone has the largest harvest in the world; three times more than the production level in Brazil and almost double the production level in Thailand and Indonesia (FAO, 2007). IITA (2005) ascribed the large harvest in Nigeria to population explosion (growth), internal market demand, availability of high yielding improved varieties of cassava tuber and increase hectares of farm land allocated to cassava in the country. Conversely, in a study to assess the trends of cassava production since 1990, Ezedinm *et al*., (2007) opined that the increase in production in Nigeria is principally as a result of area expansion rather than increased yield/ha. Given the several uses for which the crop has been subjected to, Cassava has thus far become veritable (Powerful) tool to eradicate poverty in Africa and escape hunger (Muhammad et al, 2012).

Compared with other major staples, cassava proves more egalitarian because of its low cash input cost (Nweke, 2004). It was not until the late 1960s that serious attention was given to research on cassava, with the establishment of CIAT in Colombia and IITA in Nigeria. Programs at these two institutions substantially augment the commendable work that had been done in Brazil and East Africa. The belated attention on cassava sought to exploit its potential for feeding people (especially the poor) in the tropic. Its advantages for the purpose were its wide range of climatic adaptability, tolerance of soils having low nutrient status, resistance to drought, ease of cultivation and potential achieving high yields; all aimed at maximizing the potential of the crop.

Among the serious bacterial diseases of cassava, the most important bacterial disease that limits cassava production on world-wide basis is Bacterial blight (CBB) after cassava mosaic disease. The disease is induced by the bacterium, *Xanthomonasxonopodispv. Manihotis* (Vauterin*et al*., 1995), distributed mainly by infected cutting (Banito*et al.,* 2008). The other economic important diseases of cassavaare bacterial leaf spot (induced byXanthomonascassavae) suspected to be a strain of *Xanthomonasmanihotis* but is now considered to be in separate species; bacterial stem rot (induced by *Erwiniacarotovora var. carotovora* group) and bacterial stem gall. *Xanthomonasaxonopodispv. Manihotis* is characterized by symptoms comprising water –soaked angular leaf spots, leaf blight and wilt, defoliation, exudation on stems, petiole and leaves, vascular necrosis and die-back (Wydra et al., 2007).

Cassava yield losses of more than 50%-75% due to CBB have been reported (Wydr and Rudolph 1999; Wydra 2002; Zinsou et al., 2004). In the humid low land of Africa, where 60% are affected, yield losses due to CBB are estimated at 3.2 million tons. As posited by Wydra*et al.,* (2002);Wydra*et al*.; (2003), in West Africa, loss of root yields up to 76% was recorded with the highest loss in the savannah zone. During the epiphytotic year of 1970-1975 when losses in central Africa were as high as 80% CBB contributed immensely to starvation in Zaire (Lozano *et al*., 1986). In the Northern and central areas of Punjab, bacterial leaf blight (BLB) disease epidemically damaged the rice crop particularly during 1997, 2002, 2006, 2007 and 2008. Absence of resistant varieties against BLB disease in the famous basmati varieties is one of the main reasons for these epidemics. In Bangladesh bacterial blight (BB) has become a major rice disease in the last few decades since the introduction and widespread growing of nitrogen-responsive modern cultivars. In 1972 and 1974, Cassava Bacterial Blight (CBB) caused a near famine in all cassava growing parts of Africa, Asia, Caribbean and Oceania (Ikotun, 2011).With the level of yield loss attributed to Cassava bacterial blight and the present push by the government of Nigeria to increase yield of cassava to meet both food and industrial needs, the need to monitor the improved varieties in the field cannot be overemphasized.

2. Materials and Methods

2.1. Experimental Site, Design and Layout

The experiment was conducted at the Research Farm land of the Department of Botany, University of Ibadan, Nigeria. Ibadan. Ibadan, the capital of Oyo State is in derived savannah Agro-ecology. The vegetation is predominantly grass with interspersed tress. It is located on longitude $3^{0}54^{1}$ of Greenwich Meridian and latitude $7^{0}54^{1}$ north of equator (Agbola and Ojeleye, 2007).

The city is elevated at about 234 meters above sea level and it is situated on gently rolling hills running in a northwest /southeast direction (Agbola and Olurin, 2000). Rainfall is bimodal with annual total of about 1550mm. Rains stabilize in May with peaks in July and September. The soil was sandy loam with little clay content, which was previously undermuccuna.

2.2. Collection and Varieties Used for the Experiment

The improved cassava variety stems were collected at the Research farm of the International Institute of Tropical Agriculture, Ibadan in Oyo State, Nigeria. These were TMS 30572, TME 419, TMS 91/02324, TMS 92/0326, TMS 98/0505, and TMS 98/05811 (TMS 581 served as an improved check). The six genotypes were planted during the 2011 planting season (on the 18th July 2011). The site was cleared, harrowed and ridged with hoe. No fertilizer was applied.

The field layout was a Randomized Complete Block Design replicated four times. The plot size was 20m x 41m.Planting distance was 1 x 1m on the crest of the ridges. Thus, the stem cuttings per genotype were planted by placing the cuttings into the soil in slanting position and two-third of each cassava stake buried in the soil (Kalu, 1991).

2.3. Disease Assessment

At 9 months after planting (MAP), plants were assed for disease incidence and severity for each genotype. The following terms are used according to definitions proposed by the Federation of British Plant Pathologists (1973): **Incidence-** frequency of occurrence of disease, expressed as the proportion of plants affected in a given population; **Severity-** intensity of disease in an individual plant expressed as rating on a numerical scale. The assessment of CBB incidence/severity in the farm was made on 30 randomly selected cassava stands from each genotype by visually counting the number of CBB infected leave. The assessment for severity was done at 3,6 and 9 months after planting (MAP), following the 1-5 scale scoring system described by Wydra and Msikita (1995) here; 1 = no symptom, 2= only angular leaf spot, 3= angular leaf spots, wilting, blighting, defoliation, and some exudates on stems/petiols, 4 = blighting of leaves, wilting, defoliation, exudates, and tip die-back, 5 = blighting of leaves, wilting, defoliation, exudates, tip die-back, and plant stunting. Disease incidence was calculated by the percentage of plants with typical CBB symptoms in each genotype while symptom severity was determined in classes. Means of the classes were calculated and described as scores. The under listed standard scale as posited by Perreaux*et al*., (1978) was used in scoring each variety for CBB severity.

Ranges of scores	Interpretation
1.0-1.4	Highly Resistant (HR)
1.5-1.9	Reactant (R)
2.0-2.4	Moderately Resistant (MR)
2.5-2.9	Moderately Susceptible (MS)
3.0-3.4	Susceptible (S)
3.5-4 or 5	Highly Susceptible (HS)

Table 1

3. Results

Six improved cassava genotypes were screened for their susceptibility to cassava bacterial under natural environment at the Botany research farm of the University of Ibadan. Cassava bacterial blight was fairly present in all the varieties evaluated. Statistical analysis revealed that the highest CBB incidence (35.70%) was recorded in TMS 30572 and the lowest incidence (17.81) was observed in TME 419 and TMS 02324 respectively. Overall, mean CBB incidence for the entire varieties was (26.19%). CBB severity was very moderate at varying levels among the varieties. The severity score range from 1.25 to 2.50 on a scale of 1-5. Moderate severity score of 2.5 was observed in TMS 581, TMS 505 and TMS 30572 respectively, while the rest of the verities (TME 419, TMS 326, and TMS 505 and 30572 respectively, while the rest of the verities (TME 419, TMS 326, and TMS 2324) recorded a highly resistant disease severity ranging from 1.25 to 1.75. The grand mean severity for all the variety was observed to be quite low (1.88%).

Genotype	Interaction	Incidence	Severity (1-5)
TMS 2324	R	17.85	1.75
TMS 30572	MR	35.71	2.50
TMS 326	R	25.00	1.50
TME 419	HR	17.85	1.25
TMS 505	MR	28.57	2.25
TMS 581	MR	32.14	2.0

Table 2: Mean disease incidence and severity score at 3, 6, and 9 months after planting (MAP).
Key: R=Resistant, MR=Moderately Resistant, R= Resistant, HR= Highly Resistant, MR= Moderately Resistant.

The total number of roots per plant and per plot also varied with variety. The highest number of roots (82.72%) was observed in TME 419followed by TMS 0326(79.5%).

The least number of roots (58.75) was observed in TMS 30572. The mean number of roots was found to be (69.92%) among the varieties (Table 9). The highest root weight (18.8kg) was observed in TME 419 followed by TMS 30572while the least root weight (11.38kg) was observed in TMS 505, suggesting that in terms of root production, the varieties reacted differently to the soil fertility at the experimental site. The grand mean for the root weight was found to be (14.7kg). Furthermore, there was no significant difference among the root weight within the varieties. The highest number of plants stands (7.00) before harvesting was found in TME419. The least was recorded in TMS 581.

VARIETY	NOOF PLANTS	NO OF ROOTS	ROOT WEIGHT (Kg/PLOT)
TMS 2324	6.50	75.25	15.25
TMS 30572	5.50	58.75	14.00
TMS 326	6.75	79.50	14.90
TME 419	7.00	82.75	18.90
TMS 505	6.00	63.75	11.37
TMS 581	4.75	59.50	4.75

Table 3: Varietal mean performance for number of plants, total root number, and total root weight (Kg/plot)

NO OF ROOT			ROOT WEIGHT		NO OF PLANT		
SOURCE	DF	MS	Pr>F	MS	Pr>F	MS	Pr>F
REP	3	1337.9	0.0427	55.30	0.1561	3.83	0.2115
VAR.	5	444.9	0.3745	24.17	0.5193	2.87	0.3293
ERROR	15		384.6		27.54		2.27
TOTAL	23		12007.8				
R-SQUARE			**0.519550**		**0.409757**		**0.431755**

Table 4: Analysis of variance for number of roots, total root weight (Kg/Plot), and number of plant stand for six varieties evaluated for CBB under natural environment

Table above shows the analysis of variance (ANOVA) for root number, root weight and number of plant stands prior to harvesting for the six cassava varieties. From the table, it can be deduced that there was no significant relationship in all the parameters measured.

	Root Weight (Kg/Plot)	**CBB incidence**	**CBB Severity**
Total roots /plot	0.73804	-0.88895	**-0.92743**
	0.0939	**0.0178**	**0.007**
Root	1	-0.65425	**-0.79267**
Weight (Kg/Plot)		0.1587	**0.054**
CBB incidence	1	0.82808	
			0.0418

Table 5: Showing Pearson Correlation Coefficients between varietal yield and incidence /severity of CBB on six IITA improved cassava varieties under natural environment

Pearson correlation analysis of diseases severity and varietal root yield further revealed significant negative correlation between root yield, total root weight, CBB incidence and severity among the varieties screened (R=-0.92743, P=0.0077, and R=-0.79267 and P=0.054)

4. Discussion and Conclusion

The tolerance of the varieties (improved) was remarkably stable in the field. Results from screening of six IITA improved cassava genotypes under natural environment revealed a varying response of the varieties to CBB disease expression and severity. Genotypes TMS 2324, TMS 326, and TME419 showed a resistant severity score of 1.5-1.9 with high yield. Based on earlier findings on CBB pathogen, infection/ spread are strongly influenced by the amount of rainfall, relative humidity, temperature and other environmental parameters. Amount and frequency of rainfall as at the time of this experiment was relatively high and this would have been expected to affect disease expression among the improved varieties. A similar trend in CBB severity had been observed in improved cassava varieties by Oduro*et al*., (1999) in Port Harcourt area of Nigeria. Terry (1976) had opined that CBB disease was prevalent in Ibadan Nigeria mainly during the rainy season as the pathogen required moisture to enhance its survival. Genotype TMS 30572 a widely distribute improved cultivar along with that of observation agrees with Banito et al., (2008). The result also corroborates with that of Amusa*et al*., (2008) who observed a moderate susceptibility to CBB in improved cassava genotypes under natural environment. The low incidence and severity score might have been due to the fact that the varieties were bred for resistance to cassava mosaic disease which had been documented to be linked to bacterial blight pathogen resistance (Hahn and Keyser, 1985). In order words, the six improved varieties screened under natural environment hold promise for resource poor farmers in the sampled area.

Varietal mean performance across the varieties also varied. TME 419 recorded the highest number of roots per plot. By extension, this translates to the highest number of marketable root yield per plot. No significance difference was found in terms of root number; this implies that in terms of root number the varieties reacted the same way to the prevailing environmental factors. This conforms to the assertion of Afolabi*et al*., (2011). Furthermore, no significance difference was found in terms of the root weight. Overall, the genotypes were all observed to be consistent in number of plant stands. Sprouting survival determines eventual plant population per unit area and the harvestable yield obtained and also influence land use efficiency. This may be unconnected with the high sprouting vigor associated with the improved lines (data not shown). This is also characteristic advantage among others farmers stand to gain by fully adopting improved cassava genotypes. Again, the exceptional reaction of the improved varieties under field condition appears marginal when considering the fact that they were originally bred for resistance to pests and diseases.

The varieties screened under natural environment showed a remarkable moderate to resistance to CBB incidence and severity even under high CBB pressure area like Ibadan, for this, farmers are advised to replace local varieties with improved cassava production. Hence, the present study underscores the need for farmers to fully adopt planting of disease-free cassava stems to reduce the high incidence level of CBB in their farms in order to maximize the potential in cassava production in Oyo State in the long run.

Correlation analysis revealed a significant negative relationship between root yield and CBB incidence and severity. This implies that the severity, the higher will be the yield loss to CBB.

5. Recommendations

The study underscores the need to adopt other disease management strategies such as organizing training programs, workshops, and seminars addressing cassava diseases for the farmers as this would aid reducing severity and incidence in the farmers' field and improve food security.

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