

# Evaluation of Some Improved Varieties of Cassava (*Manihot esculenta*) (Crantz) for Resistance to Cassava Bacterial Blight (CBB) in a Humid Forest Zone of Nigeria

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## ABSTRACT

Ten improved varieties of cassava *Manihot esculenta* (Crantz) obtained from the International Institute of Tropical Agriculture (IITA) Ibadan and a local variety (Efuwa) which served as a local check were evaluated for resistance to Cassava Bacterial Blight (CBB) at the Rivers State Agricultural Development Programme (ADP) Research Farm, Degema, Rivers State, Nigeria. The varieties were laid out in a Randomized Complete Block Design and replicated three times. Field observation shows that seven varieties were resistant to CBB infection with proportional increase in tuber yield. Two categories of varieties were observed in the study. The first category which have higher resistance to CBB and good tuber yield thus having potential in reducing foliar diseases as well as increasing tuber yield, while the second category produces relatively higher biomass and good tuber yield. This group can therefore be cultivated for good foliage and tuber yield. The root number weight and above-ground biomass had a significant positive correlation with yield, while a negative correlation exists between incidence/severity and yield. Therefore, Varieties with high level of resistance are recommended for crop multiplication in humid rain forest zone of Nigeria.

**Keywords:** Cassava bacterial blight (CBB), Improved varieties, Resistance, Local check and tuber yield.

## INTRODUCTION

Cassava is one of the most important staple food crops in Africa. The crop's production is among the most staple of the world's major food crops. The storage roots can be left in the ground for up to three or more years, making it available to consumers for a long period. The leaves are also widely consumed as vegetable in several countries in Africa. It can grow on a wide range of soils and can yield satisfactorily where most other crops fail (Hahn, 1984). It can grow in high rainfall areas and also in semi-arid regions because of its drought tolerance. The crop, therefore, plays a vital role in alleviating famine by providing sustained food supplies when other crops fail. Despite the numerous advantages that cassava offers to millions of African producers and consumers, there were very little research and development activities on the crop in the continent until recently. This is partly due to the fact that the crop is erroneously considered as inferior since it is cheaper than cereals and the fact that there are numerous constraints in the production of the crop. As a result, concerted efforts are being made to overcome the numerous constraints that limit cassava

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production in the continent, particularly Nigeria. Among such constraints are diseases such as mosaic virus and cassava bacterial blight. Cassava bacterial blight caused by *Xanthomonas campestris* P.v. *Manihotis* is present in almost all cropping areas. It was first reported in Nigeria in 1972 (Boher and Agboli, 1995). It starts during the rainy season with the establishment of the parasite on foliage. Bacteria from contaminated plants or plant debris in the soil are transmitted to the leaves by rain splash or insects. The bacteria then multiply on the underside of the leaves, where they form micro-colonies protected by mucus (Daniel and Boher, 1985a). This epiphytic multiplication contributes to the buildup of inoculi sufficient to contaminate lamina tissue through stomata or the wounds that are frequently caused by high winds. Leaf blight may occur as a result of a toxin produced by the parasite (Perreaux, Marate and Meyer, 1982).

In the absence of rainfall, the parasite stops spreading in the issues and the epiphytic populations disappear. The parasite can survive in stem and seed tissues and in plant debris which fall to the ground, but not in the soil (Daniel and Boher, 1985b). The disease cause loss of yield of tubers and planting material, thereby posing a threat to national food security. It is against this backdrop that International Institute of Tropical Agriculture (IITA) initiated the development of improved cassava varieties which are disease resistant and high yielding. The improved varieties are however becoming less or moderately resistant to Cassava bacterial blight (CBB) (Omodiji, Oyedokan and Akinlosotu, 1988; Osakwe, Ikpe, Adeniji and Folorunsho, 2000). The objectives of this study therefore are to:

- (i) Evaluate the level of resistance of various varieties of bacterial blight on farm and
- (ii) Ascertain the relationship between the disease and tuber yield of cassava.

## MATERIALS AND METHOD

This experiment was conducted on a typical sandy loam soil at Rivers State Agricultural Development Programme (ADP) Research farm, Degema, Rivers State. This farm is located in the high rainfall areas of Nigeria. Annual rainfall is variable and ranges from an average of 2,000 to 2,500 mm (FAO, 1984). The rainfall pattern is essentially bimodal with peaks in July and September and periodically low precipitation in August, the annual temperature ranges between 25°C and 28°C. The experimental plot was previously cultivated with vegetable (Okra) and was dominated by grasses and sedges among which are *Sida acuta*, *Ageratum conizoides* (L.), *Panicum maximum* (Jacq) and others.

All soil analysis were done according to procedures outlined by Tel and Rao (1982). Soil samples from five points at 0 – 15 cm and 15 – 30 cm were collected per location for chemical analysis in the laboratory. Samples were air-dried and analyzed in the laboratory for soil pH with Coleman pH meter using soil “saturation extract” (Soil-water, 1:1 ratio, w/vol) and soil – potassium chloride ratio 1:2:5 w/vol. Total *N* was determined by the semi-micro kjeldahl digestion method as modified by Tel and Rao (1982), while available *P* was determined by the Bray and Kurtz No. 1 method (Tel and Rao, 1982). Exchangeable *K* was extracted with neutral normal ammonium acetate buffered at pH 7.0. Potassium (*K*) in the extract was measured by flame photo-meter (Tel and

Rao, 1982). Cadmium (Ca) and Magnesium (Mg) in the extract were determined by EDTA Complex metric titration (Tel and Rao, 1982). The field was laid out in a randomized complete block design and replicated three times. Each block measured 464m<sup>2</sup> containing eleven plots. The plots measured 5.0 x 5.0m each. The cassava cuttings were spaced at 1.0 x 1.0m. The ten cassava varieties evaluated included 99/6012, 96/1632, TMS 30572, 98/0002, 91/02324, 98/2101, 97/3200, 94/0026, 96/1642, 97/0162 and local best (Efuwa) which served as the control. These varieties were evaluated for resistance to bacterial blight under natural infection.

The cassava cuttings were planted on the flat after clearing. Since cassava plants are sensitive to weed competition during the early part of their growth, manual weeding was done at 4, 8, 12 and 18 weeks after planting (WAP). Observations on sprouting were carried out at 1, 2, and 3 (WAP). The number of sprouts per cutting was counted until fill or near 100% emergence (complete sprouting was calculated and numbers of nodes were counted). Initial plant growth vigour 3 WAP was rated on scale (modified from CIAT 1983). Incidence of CBB was recorded as the number of cassava plants showing leaf symptoms over the total number of plants per treatment multiplied by 100 (IITA 1990a).

$$\frac{\text{Number of infected plants}}{\text{Total number of plants per treatment}} \times 100$$

**Severity of CBB:** Severity scoring was done thrice, first at the beginning of rainy season, (May), second at the peak of rainy season (September) and third at the end of the rainy season (IITA 1990b). The following scoring system was used.

0 = No symptoms observed.

1 = only angular leaf sprouting.

2 = Exclusive leaf blight, leaf wilt and defoliation and gum exudation on stems and petioles

3 = Extensive leaf blight, wilt and stem die-back

4 = Complete defoliation and stem die-back of lateral shoots.

The total number of leaves was counted. This was carried out by counting the number of leaves per stem or per plant basis (IITA, 1983). The total number of branches was counted at 3 and 6 months after planting (MAP). The leaf area was determined by tracing (graph) method. Tuberos roots are those that are thicker than 0.5cm to 1cm. If tuberos roots are formed, a separation of these can be done according to their diameter into small, intermediate, large classes (IITA, 1990a). Subsequently, fresh weight analysis was done on the basis of these individual classes. Data obtained were subjected to analysis of variance (ANOVA). The means of the treatments found to be significant were compared using New Duncan Multiple Range Test (NDMRT) according to procedures of statistical Analysis System (SAS, 1991). Correlation was also done to determine the relationship among parameters.

## RESULTS AND DISCUSSION

**Incidence of CBB:** The peak incidence period was maintained at 3 MAP but declined at 6 MAP for virtually all the varieties except local best, TMS 30572 and 91/02324 (Table

1). For some others, no incidence of CBB was observed at 1 MAP. This was noted for 96/1632, 91/02324, 98/2101, 97/3200, 94/0026, 96/1642, 97/0162. Some fluctuations in incidence of CBB were noted at 1 MAP, 3 MAP and 6 MAP for local best, TMS 30572 and 91/02324, TMS 30572 maintained an increase in incidence from 1 MAP until 6 MAP while incidence increased between 1 MAP and 3 MAP but declined at 6 MAP for local best. However, incidence of CBB was only observed at 6 MAP for 91/02324. On a general note, the incidence of CBB shows that 91/02324 and 97/0162 were more resistant while local best and TMS 30572 were susceptible to the disease.

**Severity of CBB:** Field observation of cassava varieties reveals the occurrence of bacterial blight, though the severity was mild. Significant difference occurred among varieties of severity of cassava bacterial blight (CBB) at one month after planting (1 MAP), 3 MAP and 6 MAP (Table 2). The highest severity was at 3 MAP then severity declined at 6 MAP for some varieties like 99/6012, 98/0002, 94/0026 and 96/1642. It was observed that there was significant increase in severity between 1 MAP and 3 MAP for these varieties but declined at 6 MAP. There was neither decline nor increase in severity between 3 MAP and 6 MAP for local best and TMS 30572. However, severity increased slightly between 3 MAP and 6 MAP for 91/02324, 97/3200.

The cassava varieties exhibit varying degrees of resistance to bacteria blight 94/0026 compared favourably with six other resistant varieties. The increase in severity and incidence of CBB with time (the beginning and peak of rainy season) observed for the varieties suggest that high rainfall favours the spread of the disease. This is in agreement with the findings of Hahn, Isoba and Ikotun (1989) and IITA (1990) who report an increase in incidence and severity of CBB over a period of six months on both resistant and susceptible genotypes under similar environmental conditions. Results from this study show that incidence and severity of the disease decline at the end of the rainy season. These agree with the findings of Daniel and Boher (1985) who report that in the absence of rainfall, the parasite *Xanthomonas campestris* pv. *Manthotis* stop spreading in the tissues and the epiphytic populations disappear. The parasite can survive in stem and seed tissues and in plant debris which fall to the ground, but not in the soil. This observation however, negates the assertion of Parsley (1989) who report that CBB is usually severe in grassland region where rainfall is barely sufficient with a long dry season of 5 - 7 months and where cassava is grown mainly as a monocrop.

**Branching and leaf development of various varieties:** Significant differences were also observed for number of branches/leaves. The number of branches increased between 3 MAP and 6 MAP for all varieties except 98/0002 and 98/2101 which maintained the same number of branches at 3 MAP. TMS 30572 has the highest number of branches while 98/0162 has the lowest. The number of leaves also increased as the months increased. TMS 30572 also recorded the highest number of leaves. A reduction in the number of leaves was noted between 3 MAP and 6 MAP for 91/02324 as shown on table 3. The result from number of branches and leaves suggests that the number of leaves produced is determined by the number of branches, hence the higher the number of branches, the

higher the number of leaves. The implication of this is that TMS 30572 can be grown as a dual purpose variety: for leaf production (which is used as vegetable by many African families) and tuber yield. Leaf area continued to enlarge with time (1, 3 and 6 MAP). This confirms earlier findings by Hunt, Wholey and Cook (1997) that cassava leaves produced at different times throughout the plant's life cycle appear to be different in size. The process of producing new leaves, the time required for expansion and rate of leaf growth can be dependent on the genetic makeup of the plant.

**Effect of bacterial blight on yield and yield component:** The yield components, number of roots, weight of roots, above-ground biomass and fresh tuber yield show significant difference (table 4). Number of small roots ranged between 14 for 97/3200 and 41 for 96/1642; variety 99/6012 recorded the highest number of large roots. Weight of small roots ranged between  $29 \pm 11$  for 94/0026 and  $19 \pm 2$  for 97/3200. Highest above-ground biomass yield was also recorded by 99/6012 as compared to 97/3200 that gives the lowest yield. The highest total yield was recorded by 94/0026. Local best and five others give yield comparable to 94/0026. It could be deduced, therefore, that when the improved varieties get adapted to the agro-ecology, their resistance tend to diminish.

**Yield/Yield Components:** Negative correlation exists between disease incidence/severity and yield. This implies that increase in incidence/severity amounts to yield reduction, while decrease in incidence/severity enhances high yield. Therefore, yield could be improved by selecting for disease resistant varieties. Among the varieties studied, 94/0026 had the highest fresh tuber yield. This is not unexpected, being that this variety has very low susceptibility to the disease with very mild spotting on the leaf. This is in line with the study by Boher and Agboli (1995) which show that the leaf is the target of the bacterial disease which in severe cases lead to defoliation. This premature defoliation results in loss of tuber yield. The result from this study has established the fact that cassava bacterial blight is one of the major disease that pose a serious threat to the increased production of cassava (IITA, 1990). Yield reduction up to 92% in susceptible cultivars have been reported (Umemure and Kawano, 1983).

This study also reveals some resistant varieties such as 98/2101, 97/3200 and 91/02324 which have low yield. This suggests that the improved varieties are becoming less resistant to cassava bacterial blight (Osakwe, Ikpe, Adeniji and Folorunsho, 2000). It is important to note that there was no significant correlation between leaf area and yield. This result could be attributed to the spotting, wilting and distortion on the leaves of the varieties evaluated. These symptoms caused by bacterial disease altered the plant's leaf surface area which may have affected light interception to an appreciable extent, hence, reduce photosynthetic activity. According to Hunt, Wholey and Cook (1997), a plant's total leaf surface area determines the maximum amount of photosynthetic product which it can produce. The observation made in this study with respect to leaf area negates the assertion of Dale and Milthorpe (1983) who report that leaf physiology is a significant factor controlling crop productivity which is particularly noticeable in cassava. Root number, weight and above-ground biomass had a significant positive correlation with yield. This

suggests that the number and weight of the roots may affect yield to an appreciable extent. Another factor that could influence yield despite infection is the fact that cassava in the humid forest zone of Nigeria passes through three seasons in one life cycle. It is planted between April – September (rainy season) grows through October – March (dry season) and harvested between April – September of the following year (rainy season). This period of 12 months enables some varieties severely infected early in the growth cycle to recover and yield economically (IITA, 1990).

**Table 1:** Incidence of CBB on selected cassava varieties

Treatments	Incidence (%) months after planting		
	1	3	6
Local best	43 ± 25 <sup>a</sup>	45 ± 13 <sup>b</sup>	42 ± 7 <sup>b</sup>
99/6012	20 ± 2 <sup>b</sup>	48 ± 6 <sup>a</sup>	46 ± 2 <sup>a</sup>
96/1632	5 ± 0 <sup>b</sup>	24 ± 7 <sup>c</sup>	0 ± 0 <sup>d</sup>
TMS 30572	5 ± 3 <sup>b</sup>	20 ± 4 <sup>cd</sup>	23 ± 3 <sup>c</sup>
98/0002	5 ± 1 <sup>b</sup>	17 ± 1 <sup>cd</sup>	4 ± 0 <sup>d</sup>
91/02324	0 ± 0 <sup>b</sup>	0 ± 0 <sup>c</sup>	4 ± 0 <sup>d</sup>
98/2101	0 ± 0 <sup>b</sup>	5 ± 1 <sup>d<sup>e</sup></sup>	4 ± 0 <sup>d</sup>
97/3200	0 ± 0 <sup>b</sup>	5 ± 1 <sup>d<sup>e</sup></sup>	4 ± 0 <sup>d</sup>
94/0026	0 ± 0 <sup>b</sup>	15 ± 1 <sup>cde</sup>	0 ± 0 <sup>d</sup>
96/1642	0 ± 0 <sup>b</sup>	5 ± 1 <sup>d<sup>e</sup></sup>	0 ± 0 <sup>d</sup>
97/0162	0 ± 0 <sup>b</sup>	4 ± 0 <sup>d<sup>e</sup></sup>	0 ± 0 <sup>d</sup>

*MAP (Months after planting)*

Means with same alphabets along the column are not significantly different from one another

**Source:** Experimentation, 2013 - 2014

**Table 2:** Severity of CBB selected cassava varieties

Treatments	Incidence (%) months after planting		
	1	3	6
Local best	2 ± 0 <sup>a</sup>	3 ± 0 <sup>a</sup>	3 ± 0 <sup>a</sup>
99/6012	2 ± 0 <sup>a</sup>	3 ± 0 <sup>bc</sup>	1 ± 0 <sup>c</sup>
96/1632	1 ± 0 <sup>c</sup>	2 ± 0 <sup>bc</sup>	1 ± 0 <sup>d</sup>
TMS 30572	2 ± 0 <sup>b</sup>	3 ± 0 <sup>ab</sup>	3 ± 0 <sup>b</sup>
98/0002	2 ± 0 <sup>a</sup>	3 ± 0 <sup>a</sup>	2 ± 0 <sup>c</sup>
91/02324	1 ± 0 <sup>c</sup>	1 ± 0 <sup>e</sup>	2 ± 0 <sup>c</sup>
98/2101	1 ± 0 <sup>c</sup>	1 ± 0 <sup>d<sup>e</sup></sup>	2 ± 0 <sup>d</sup>
97/3200	1 ± 0 <sup>c</sup>	2 ± 0 <sup>d<sup>e</sup></sup>	2 ± 0 <sup>d</sup>
94/0026	1 ± 0 <sup>c</sup>	2 ± 0 <sup>cd</sup>	1 ± 0 <sup>d</sup>
96/1642	1 ± 0 <sup>c</sup>	2 ± 0 <sup>cd</sup>	1 ± 0 <sup>d</sup>
97/0162	1 ± 0 <sup>c</sup>	2 ± 0 <sup>e</sup>	1 ± 0 <sup>d</sup>

*MAP (Months After Planting)*

Means with same alphabets along the column are not significantly different from one another

**Source:** Experimentation, 2013 - 2014

**Table 3:** Branching and leaf development of selected cassava varieties

Treatment	Branches		Leaves Leaf		Area (cm <sup>2</sup> )		
	3MAP	6MAP	3MAP	6MAP	1MAP	3MAP	6MAP
Local best	24 ± 3 <sup>b</sup>	37 ± 3 <sup>b</sup>	318 ± 16 <sup>b</sup>	592 ± 51 <sup>b</sup>	27 ± 3 <sup>c</sup>	65 ± 3 <sup>d</sup>	76 ± 3 <sup>d</sup>
99/6012	9 ± 4 <sup>cd</sup>	10 ± 5 <sup>cde</sup>	73 ± 44 <sup>c</sup>	139 ± 87 <sup>d</sup>	70 ± 1 <sup>c</sup>	79 ± 2 <sup>d</sup>	139 ± 1 <sup>d</sup>
96/1632	13 ± 6 <sup>d</sup>	18 ± 8 <sup>cd</sup>	140 ± 59 <sup>c</sup>	281 ± 142 <sup>ab</sup>	43 ± 2 <sup>c</sup>	53 ± 2 <sup>d</sup>	72 ± 2 <sup>c</sup>
TMS 30572	44 ± 5 <sup>b</sup>	74 ± 8 <sup>a</sup>	619 ± 74 <sup>b</sup>	1264 ± 124 <sup>a</sup>	37 ± 2 <sup>c</sup>	73 ± 2 <sup>d</sup>	101 ± 2 <sup>d</sup>
98/0002	2 ± 0 <sup>b</sup>	2 ± 1 <sup>c</sup>	34 ± 14 <sup>c</sup>	70 ± 26 <sup>d</sup>	17 ± 1 <sup>b</sup>	21 ± 1 <sup>d</sup>	97 ± 2 <sup>d</sup>
91/02324	2 ± 0 <sup>b</sup>	2 ± 0 <sup>e</sup>	26 ± 4 <sup>c</sup>	51 ± 9 <sup>d</sup>	63 ± 2 <sup>c</sup>	104 ± 3 <sup>b</sup>	113 ± 3 <sup>c</sup>
98/2101	12 ± 1 <sup>d</sup>	16 ± 2 <sup>cd</sup>	103 ± 10 <sup>c</sup>	211 ± 15 <sup>d</sup>	84 ± 1 <sup>c</sup>	157 ± 3 <sup>d</sup>	169 ± 3 <sup>c</sup>
97/3200	4 ± 0 <sup>b</sup>	7 ± 1 <sup>d</sup>	46 ± 7 <sup>c</sup>	84 ± 14 <sup>d</sup>	34 ± 2 <sup>c</sup>	41 ± 2 <sup>d</sup>	76 ± 2 <sup>c</sup>
94/0026	10 ± 2 <sup>ab</sup>	17 ± 4 <sup>cde</sup>	146 ± 33 <sup>c</sup>	300 ± 63 <sup>ab</sup>	51 ± 2 <sup>d</sup>	103 ± 5 <sup>b</sup>	162 ± 2 <sup>b</sup>
96/1642	15 ± 3 <sup>b</sup>	24 ± 3 <sup>c</sup>	66 ± 71 <sup>b</sup>	433 ± 183 <sup>b</sup>	55 ± 2 <sup>d</sup>	63 ± 1 <sup>d</sup>	170 ± 1 <sup>c</sup>
97/0162	1 ± 0 <sup>b</sup>	2 ± 1 <sup>e</sup>	32 ± 16 <sup>c</sup>	54 ± 23 <sup>d</sup>	40 ± 2 <sup>e</sup>	60 ± 1 <sup>b</sup>	124 ± 2 <sup>d</sup>

Means with same alphabets along the column are not significantly different from one another

Source: Experimentation, 2013 - 2014

**Table 4:** Yield and Yield Components

Treatment	Root number		Root Weight Yield		Above Ground Biomass (t/ha)	Total Yield (t/ha)
	Small (no/ha)	Large (no/ha)	Small (no/ha)	Large (no/ha)		
Local best	25 ± 5 <sup>b</sup>	72 ± 8 <sup>b</sup>	1.08 ± 0.4 <sup>abc</sup>	26.92 ± 5.8 <sup>bc</sup>	8.24 ± 5.3 <sup>ab</sup>	28.00 ± 5.5 <sup>bd</sup>
99/6012	15 ± 2 <sup>c</sup>	120 ± 7 <sup>a</sup>	0.84 ± 0.2 <sup>abc</sup>	33.88 ± 2.0 <sup>b</sup>	23.32 ± 2.0 <sup>b</sup>	34.72 ± 2.1 <sup>b</sup>
96/1632	20 ± 3 <sup>b</sup>	77 ± 4 <sup>b</sup>	0.88 ± 0.5 <sup>abc</sup>	29.08 ± 2.0 <sup>ab</sup>	12.92 ± 1.8 <sup>b</sup>	29.96 ± 2.4 <sup>b</sup>
TMS 30572	34 ± 1 <sup>a</sup>	72 ± 4 <sup>b</sup>	1.44 ± 0.4 <sup>bc</sup>	26.28 ± 1.8 <sup>bc</sup>	10.68 ± 2.0 <sup>b</sup>	27.72 ± 0.8 <sup>bd</sup>
98/0002	20 ± 5 <sup>bc</sup>	76 ± 2 <sup>b</sup>	0.92 ± 0.6 <sup>aba</sup>	24.92 ± 2.0 <sup>b</sup>	8.8 ± 1.2 <sup>cb</sup>	25.88 ± 2.2 <sup>b</sup>
91/02324	25 ± 3 <sup>bc</sup>	65 ± 2 <sup>b</sup>	1.16 ± 0.3 <sup>ab</sup>	17.08 ± 2.7 <sup>c</sup>	8.28 ± 0.9 <sup>abc</sup>	18.24 ± 3.0 <sup>b</sup>
98/2101	19 ± 2 <sup>c</sup>	40 ± 3 <sup>b</sup>	0.84 ± 0.2 <sup>ab</sup>	13.72 ± 2.0 <sup>c</sup>	4.8 ± 0.6 <sup>bc</sup>	14.56 ± 2.0 <sup>b</sup>
97/3200	14 ± 2 <sup>c</sup>	33 ± 3 <sup>c</sup>	0.44 ± 0.4 <sup>a</sup>	10.00 ± 1.7 <sup>b</sup>	3.6 ± 0.6 <sup>b</sup>	10.44 ± 1.4 <sup>b</sup>
94/0026	29 ± 11 <sup>abc</sup>	81 ± 14 <sup>b</sup>	2.24 ± 0.8 <sup>b</sup>	32.8 ± 0.7 <sup>b</sup>	21.6 ± 15.5 <sup>b</sup>	35.04 ± 2.5 <sup>b</sup>
96/1642	41 ± 2 <sup>b</sup>	81 ± 3 <sup>b</sup>	1.92 ± 0.9 <sup>ab</sup>	30.4 ± 0.6 <sup>bc</sup>	10.92 ± 0.9 <sup>ab</sup>	32.32 ± 0.7 <sup>b</sup>
97/0162	19 ± 2 <sup>c</sup>	79 ± 2 <sup>c</sup>	0.52 ± 0.3 <sup>bc</sup>	26.12 ± 0.9 <sup>bc</sup>	7.08 ± 2.0 <sup>ab</sup>	26.8 ± 0.6 <sup>b</sup>

Means with same alphabets along the column are not significantly different from one another

Source: Experimentation, 2013 - 2014

**Table 5:** Relationship between Incidence/Severity and Yield

Trt	Local Best	99/6012	96/1632	TMS 30572	98/0002	97/02324	98/3200	97/3200	94/0026	96/1642	97/0162
Sev	Inc	Sev	Inc	Sev	Inc	Sev	Inc	Sev	Inc	Sev	Inc
Yield	0.213	0.079	0.057	0.103	0.094	0.160	0.397	0.195	0.080	0.150	0.02
	0.092	0.030	0.082	0.138	0.023	0.041	0.120	0.031	0.14	0.051	0.171

**Table 6:** Relationship Between Some Parameters and Yield

LA 6 MAP	RT NO SM	RT NO LG	RT WT SM	RT WT LG
ABOVE GROUND BIOMASS	TOTAL YIELD			
LA 6 MAP				
RT NO SM				
RT NO LG				
RT WT SM				
RT WT LG				
ABOVE GROUND BIOMASS				
TOTALYIELD				

\* = \*\* = \*\*\* = , Ns = Not Significant, LA = Leaf area,

RT NO SM = Root Number (Small), RT NO LG = Root Number Large,

RT WT SM = Root Weight Small, RT WT LG = Root Weight Large,

MAP = Months After Planting

Source: Experimentation, 2013 - 2014

## CONCLUSION

This study was designed to evaluate the level of resistance of various varieties of bacterial blight on farm and ascertain the relationship between the disease and tuber yield of cassava. Ten improved varieties of cassava *Manihot esculenta* (Crantz) obtained from the International Institute of Tropical Agriculture (IITA) Ibadan and a local variety (Efuwa) which served as a local check were evaluated for resistance to Cassava Bacterial Blight (CCB) at the Rivers State Agricultural Development Programme (ADP) Research Farm Degema, Rivers State, Nigeria. This study has established that incidence and severity of CBB are both negatively correlated with tuber yield. It, therefore, suggests that farmers can use disease resistant varieties for enhanced tuber yield. Varieties 99/6012, 96/1632, 94/0026 and 96/1642 with high level of resistance are recommended for crop multiplication in humid rain forest zone of Nigeria. Other varieties such as TMS 30572, 96/1642 and 94/0026 were observed to have high foliage and tuber yield, thus serving a dual purpose.

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