Original Research Article

Natural Virus Infection on Improved Cassava (*Manihot esculenta* Crantz)Varieties in Minna, Northern Nigeria

ABSTRACT

Cassava is a major staple food source for millions of people in Africa. It is one of the most cultivated root crops and is a sustainable source of food security and family income for the poor in the developing world. Despite this economic significance, cassava yield is significantly reduced by viral diseases which can often result in 100 % yield loss in susceptible cultivars, through a field-based randomized complete block-designed experiment, the present study screened five cassava genotypes sourced from the International Institute of Tropical Agriculture (IITA) Abuja Station in Nigeria with three replications. The five genotypes were asymptomatic throughout the growing season. The growth and yield parameters were also recorded. The data was subjected to variance analysis. Results revealed that the five genotypes (PRV A, TME 419, TMS 98/0505, TMS 98/0581, and TMS 30572) were resistant to natural virus infection. However, the cassava genotypes identified in this current study could be used as parents in future breeding programs to enhance food security and improve nutrition.

Keywords: Cassava, virus, disease, resistance, growth performance,

1. INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is an essential food crop that has become well-established in tropical Africa, where it plays a critical role in food security and economic livelihoods [1]. Originating from western and southern Mexico and tropical South America, particularly Brazil [2], cassava is now the third most important source of dietary calories in the tropics after rice and maize [3]. Its processed products, rich in carbohydrates (mainly starch) and minerals, contribute significantly to daily nutritional needs [4]. Globally, cassava is the most widely cultivated root crop [5] and is of particular importance in sub-Saharan Africa, where it serves as a staple food for millions of people. In Nigeria, cassava is a cornerstone of household livelihoods, with more than 40 varieties under cultivation across 24 of the country's 36 states [6]. Its versatile applications, including food products and cattle feed, have supported the development of robust multiplication and processing systems [6]. Furthermore, cassava has become a major source of income for small-scale farmers and rural households.

Despite its importance, cassava production is severely constrained by various diseases, notably Cassava Mosaic Disease (CMD), Cassava Brown Streak Disease (CBSD), Cassava Bacterial Blight (CBB), Cassava Brown Leaf Spot (CBLS), and Cassava Anthracnose Disease (CAD) [7]. Among these, CMD and CBSD are the most significant viral diseases threatening cassava production in sub-Saharan Africa [8]. CMD, in particular, is the most severe and widespread, posing a substantial barrier to cassava cultivation and productivity in the region. CMD is caused by cassava mosaic geminiviruses (CMGs) and is transmitted by the whitefly vector *Bemisiatabaci*[9]. However, the causative agent was initially presumed to be a virus due to the absence of visible pathogens [9]. The disease manifests through a variety of foliar symptoms, including mosaic patterns, mottling, twisted leaflets, and a reduction in the size of leaves and plants. CMD-affected plants often produce few or no tubers, depending on the severity of the infection and the plant's growth stage at the time of infection. The impact of CMD on cassava farming can be profound, as it reduces farm yields, compromises the quality and quantity of harvests, and diminishes the productivity and profits of cassava farmers. In severe cases, CMD can lead to catastrophic losses for farming communities.

Currently, no cassava variety has been fully reported as resistant to CMD or other viral diseases, and the intensity of viral effects varies across different varieties. This underscores the importance of understanding the biology, transmission, and variability of these viruses to inform effective control strategies. Hence, the need to put in for this study and the objectives of the study were to

i. Determine the incidence and severity of cassava viral infections across different cassava variety's growth performance.
ii. Evaluate the morphological characteristics and yield performance of virus-infected cassava varieties.

2. MATERIAL AND METHODS

2.1 Site Description

The study was conducted at the Teaching and Research Farm, Gidan Kwano campus of the Federal University of Technology Minna, Niger State, Nigeria in the 2018/2019 planting season. The experimental site is situated at latitude 9°51'N and longitude 6°44'E, with an altitude of 212 meters above sea level. The region falls within Nigeria's Southern Guinea Savanna ecological zone, characterized by an average annual rainfall of 1200 mm. Rainfall is distributed between April and early October, peaking in September. The area experiences temperatures ranging from 35°C to 37°C, with relative humidity varying from 40–60% in

January and increasing to 60–80% around July. These conditions provide an ideal environment for cassava cultivation and evaluation.

2.2 Study Layout and Management

The experiment employed a Randomized Complete Block Design (RCBD) with five cassava varieties (treatments) replicated three times. The cassava varieties evaluated included PRO VITAMIN-A 07/0593, TME 419, TMS 98/0505, TMS 98/0581, and TMS 30572. Planting materials (cassava stems) were sourced from the International Institute of Tropical Agriculture (IITA), Abuja station. The experimental plot was manually cleared and marked out into dimensions of 20 m × 5 m. Cassava stems were planted in a spacing of 1m x 1m, and weeding was carried out manually at 4, 12, and 24 weeks after planting (WAP).

2.3 Disease Incidence and Severity

Disease incidence, the proportion of plant or plant parts diseased was measured by counting at 12 months after planting. Disease severity was measured using the score scale of those reported by Bhat et al. (2013) [10] (Table 1). Representative leaf samples were collected from the treatments, taken to the laboratory, and placed on a flat surface for a clear image of the samples. The leaf area was then measured using a meter rule and the Infected leaf or pixel area was measured using ImageJ software. The percentage of infected leaf area was calculated using the following formula:

$$\text{Percentage leaf area infected} = \frac{\text{Infected pixel area}}{\text{Total leaf area}} \text{ X } 100$$

Table 1. Rating scale for measuring disease severity

Category	score	leaf area infected (%)
I	0	Disease free
II	1	0.1 – 10
III	2	10.1 – 25
IV	3	25.1 – 50
V	4	50.1 – 70
VI	5	>70

2.4 Plant Measurements

Plant height (cm) was measured from the base of the plant to the tip of the highest leaf using a meter rule at 2, 4, 6, 8, 10, and 12 WAP. The number of branches was determined by counting the total branches per plant at 2, 4, 6, 8, 10, and 12 WAP. The number of leaves per plant was counted on each plant at 2, 4, 6, 8, 10, and 12 WAP. Harvesting was performed manually 12 months after planting. This involved using hoes to lift the lower part of the stems and manually extracting the roots from the soil. The number of roots was determined by averaging the root count of five randomly selected plants per replicate. The root length (cm) was measured using a meter rule as the average length of roots from five

randomly selected plants per replicate. Root diameter (cm) was measured with a Vernier caliper as the average diameter of roots from five randomly selected plants per replicate. Total Root Weight Per Plant (kg) was determined by weighing the total roots of five randomly selected plants per replicate using a weighing scale.

2.5 Statistical Description

All collected data were subjected to Analysis of Variance (ANOVA) using the PROC GLM procedure in the Statistical Analysis System (SAS). Significance was determined at a 5% probability level, and treatment means were separated using the Student-Newman-Keuls (SNK) test when the p-value was significant.

3. RESULTS

Across the planting season, there was no disease symptom, suggesting no disease incidence which translated to having a disease severity score of 0. Additionally, the percentage of leaf area infected was 0. The plant height showed significant differences among the treatments at 2, 4, 6, and 8 WAP, but not after or 10 and 12 WAP. The tallest plant height among the treatments across the WAP was recorded in TME 419 treatment (Table 2). Significant differences among the treatments on the number of branches per plant were recorded at 8, 10, and 12 WAP, but not at 2, 4, and 6 WAP. Greater number of branches per plant was recorded on PRVA treatment, but it was not statistically different from TMS98/0505 treatment (Table 2). Greater number of leaves per plant among the treatments across the WAP was recorded in TME 419. However, this was not statistically different from TMS98/0505 treatment (Table 3). Greater number of roots per plant, root diameter, and total root weight per plant was also recorded in TME 419 treatment. Whereas, TMS98/0505 had the greatest root length compared to other treatments (Table 3).

Table 2: Plant height and number of branches per plant from improved cassava varieties during 2018/2019 planting season at the Teaching and Research Farm, Gidan Kwano campus of the Federal University of Technology Minna, Niger State, Nigeria. Values are the means of 3 replication

Treatments	Plant height (cm)					
	2 WAP	**4 WAP**	**6 WAP**	**8WAP**	**10 WAP**	**12 WAP**
PRVA	9.35b	22.68ab	36.26b	51.63b	71.62a	86.01a
TME419	16.82a	34.62a	54.96a	76.07a	92.15a	98.27a
TMS98/0505	10.71b	26.06ab	42.31ab	61.20b	80.56a	96.71a
TMS98/0581	10.59b	23.54ab	41.10ab	57.76b	81.81a	94.17a
TMS30572	7.04b	16.92b	35.34b	50.23b	77.64a	86.53a
± SE	1.44	3.42	3.49	3.45	4.76	6.29
	Branches per plant (no)					
	2 WAP	**4 WAP**	**6 WAP**	**8WAP**	**10 WAP**	**12 WAP**
PRVA	1a	1a	2a	3a	3a	6a
TME419	2a	2a	2a	2ab	2ab	3b
TMS98/0505	2a	2a	2a	2ab	3a	4ab
TMS98/0581	2a	2a	2a	2ab	2ab	3b
TMS30572	1a	2b	2a	1b	1b	3b
± SE	0.24	0.19	0.19	0.16	0.32	0.93

Means followed by dissimilar letter (s) within the column differ significantly ($P< .05$) by Student Newman Keuls (SNK); WAP: weeks after planting

Table 3: Number of leaves per plant and yield characteristics of improved cassava varieties planted during 2018/2019 planting season at the Teaching and Research Farm, Gidan Kwano campus of the Federal University of Technology Minna, Niger State, Nigeria. Values are the means of 3 replications

Treatments	Leaves per plant (no)						RootPer plant (no)	Root length (cm)	Root diameter (cm)	Totalroot weight per plant (kg)
	2 WAP	**4 WAP**	**6 WAP**	**8 WAP**	**10 WAP**	**12 WAP**				
PRVA	5b	16b	21b	32b	42b	53b	9ab	27.16ab	2.01b	2.40b
TME419	9a	25a	30a	45a	55a	62a	11a	26.78b	3.93a	3.43a
TMS98/0505	8a	20ab	26ab	39ab	52a	60a	7b	32.11a	2.96ab	2.33b
TMS98/0581	6b	15b	22b	34b	45b	53b	10a	26.88b	2.75ab	3.00a
TMS30572	6b	14b	18b	29b	43b	51b	8b	23.67b	2.03b	1.67c
± SE	1.43	2.24	2.72	3.19	3.8	3.98	1.38	7.49	0.76	0.47

Means followed by dissimilar letter (s) within the column differ significantly (*P*< .05) by Student Newman Keuls (SNK); WAP: weeks after planting

4. DISCUSSION

Cassava virus diseases are among Africa's most significant threats to cassava production, posing challenges to food security and economic stability. To address this, continent-wide strategies have been developed to minimize virus spread. These strategies include diagnostics, prevention, control, eradication, and infection management. Key approaches include phytosanitation and breeding of improved cassava varieties that hinder virus replication, as noted by Legg et al. (2015) [11]. In this recent study, the disease-free symptoms or no symptoms observed on the planted varieties throughout the study period are inconsistent with those reported by Alabi et al. (2011) [12]. Further, this finding supports the assertion that cassava viral diseases are transmitted primarily through insect vectors such as whiteflies. Thus, the absence of symptoms indicates that all five varieties tested demonstrated immunity, which represents the highest level of resistance, characterized by a complete lack of visible symptoms in infected plants. The resistance of varieties such as TME 419, TMS 98/0505, and TMS 98/0581 has been corroborated by earlier studies, including those of Udensi et al. (2011) [13], which linked resistance to reduced disease incidence and severity under field conditions. The morphological and yield characteristics of these immune cassava varieties (Table 2 & 3), surpassed those of infected plants, highlighting the detrimental impact of viral infections on cassava's genetic potential. Statistical analysis further revealed that the five cassava varieties were genetically related, which may contribute to their shared resistance traits. Resistant cassava varieties offer numerous advantages, particularly for resource-poor farmers. They eliminate the need for costly chemical controls, reduce environmental impact, and contribute to sustainable agricultural practices [14]. The findings emphasize the importance of continued breeding programs and field evaluations to develop and disseminate resistant varieties, which can enhance cassava productivity and improve the livelihoods of farmers across Africa. Hence, the study provides critical insights into the role of genetic resistance in combating cassava viral diseases and reinforces the significance of integrating resistant varieties into cassava production systems to ensure food security and economic stability in affected regions.

5. CONCLUSION

Virus infections pose a significant threat to cassava production, often resulting in severe yield losses. The incidence and severity of these infections are largely influenced by the genetic makeup and background of the cassava cultivar. This study demonstrated the resistance of the evaluated improved cassava varieties PRVA, TME 419, TMS 98/0505, TMS 98/0581, and TMS 30572 to natural virus infections. To mitigate yield losses caused by cassava viruses, farmers are encouraged to adopt these improved, virus-resistant varieties for cultivation. These varieties not only offer resistance to infections but also exhibit high yield potential, making them suitable for commercial farming. Additionally, the development and improvement of local cassava varieties could play a crucial role in ensuring sustainable production and enhancing food security at a national level. Further research is recommended to evaluate these improved varieties against other diseases affecting cassava, ensuring comprehensive protection and continued agricultural productivity. This approach will contribute significantly to achieving stable yields and supporting food security initiatives.

CONSENT (WHEREEVER APPLICABLE)

The authors consent that the article should be published

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