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Evaluation of Growth, Yield and Susceptibility of Five Cassava Cultivars in Ilorin, Southern Guinea Savanna, Nigeria

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Abstract

Development of high yielding and disease/pest resistance cultivars are major ways of overcoming threats to cassava production in Africa. A field study aimed at evaluating the growth performance and susceptibility rating of five cassava cultivars was conducted at the University of Ilorin Teaching and Research Farm, Ilorin, Nigeria. The cassava cultivars included : TMS 92/0057, TMS 92/0326, TMS 92/30572, '*Odongbo'*, *'Oko-Iyawo'* - selected for high yield and tolerance to cassava mosaic disease (CMD), cassava bacterial blight (CBB) and cassava green spider mite (CGM). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Symptom expression of CMD was moderate in '*Odongbo'* while TMS 92/30572 had the least severity symptom. '*Odongbo'* recorded the least CGM severity of damage which was at par with TMS 92/0326 and '*Oko-Iyawo*'. Symptoms expression of CMD and CBB were generally higher with the local checks - '*Odongbo'* and '*Oko-Iyawo'* respectively while CGM symptom was significantly ($p< 0.05$) higher with TMS 92/30572. Results on growth parameters showed that least mean number of branches/plant was recorded in the local check- '*Oko-Iyawo*' which was significantly different from TMS 92/30572. Mean weight of tubers/plant was positively correlated with number of tubers/plant and negatively correlated with CMD. TMS 92/0326 recorded high harvestable tuber/ha and its pest/disease severity scores were low, suggesting that this cultivar could be recommended to farmers in the studied agro-ecological zone.

Keywords: Cassava, cultivars, tuber, pest and diseases

1. Introduction

Cassava, *Manihot esculenta* Crantz (Euphorbiaceae), is an important subsistence crop for more than 200 million people in tropical and sub-tropical Africa (Herren and Bennett, 1984). Nigeria is the world`s leading producer of cassava with an annual production of 34 million metric tons (FAO, 2002) and annual estimate of 44 million metric tons (CBN, 2004). This is

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as a result of advances in cassava improvement and development which gave rise to improved varieties that are high yielding and resistant to cassava pests and diseases (Eke-Okoro and Njoku, 2012). In Nigeria, cassava is mainly used as food consumed by more than 90% of the population. It constitutes a cheap source of carbohydrates (dietary energy) for both rural and urban communities in fresh and processed food preparations and a source of cash income (Ugochukwu, 2003). More than two-thirds of the total production of cassava is used as food for humans, with lesser amounts being used for animal feed (Nwokoro *et al.*, 2002) and industrial purposes (Tonukari, 2004). Industrially, cassava pellets are used as animal feed; ethanol is produced by fermenting and distilling cassava. Also, cassava flour which is completely gluten-free is used as a substitute for wheat flour while cassava starch extracted from the roots could be used in food industry, paper and textile industries as well as adhesive in glass, mineral, wool and clay. High quality cassava flour is used for preparing a wide range of confectioneries (Onabolu *et al*., 2003; Oti *et al*., 2005). Etejere and Bhat (1985) reported that the preparation of cassava products using traditional methods has helped to reduce the problem of carbohydrate deficiency in areas where cassava is extensively cultivated in Nigeria. Such cassava products include `gari`, edible starch, `fufu`, `akpu` cassava flour and tapioca cakes.

Pests and diseases are among the major constraints to cassava production in Africa (Theiberge, 1985). The major pests of cassava in sub-Saharan Africa are the Cassava Green Spider Mites (CGM), the variegated Grasshopper and Mealybug while the main diseases affecting cassava are Cassava Mosaic Disease (CMD), Cassava Bacterial Blight (CBB), cassava anthracnose disease and root rot. Among these biotic stresses, CMD, CBB and CGM are considered very important (Yaninek, 1994). Cassava mosaic disease, spread by whitefly and infected cuttings, is characterized by leaf mosaic patterns that affect discrete areas and are detected at the early stage of leaf development. The disease is the most devastating with yield loss between 20 and 90% (Thresh and Otim-Nape, 1994).

Cassava bacterial blight incited by *Xanthomonas campestris* pv. *manihotis* (XCM) is currently present in almost all the cassava cropping areas in Africa (Boher and Agbobli, 1992). Weeding is recommended for its control as some weed species including *Eupatorium odoratum* L., *Mariscus sumatrensis* (Retz), and *Phyllanthus amarus* can harbour the parasite (Boher and Verdier, 1994). Cassava Anthracnose Disease and CBB are spread by cuttings or mechanically by raindrops, use of contaminated farm tools, chewing insects and movement of man and animals through plantations. Cassava green spider mite (*Mononychellus* spp.) is an exotic pest of Neotropical origin causing an estimated 13-80% reduction in cassava yield in Africa (Yaninek and Herren, 1988). It occurs on the lower surface of young leaves, green stems and auxillary buds and damages usually appear as yellowish "pinpricks" on the deformed leaves and may lead to complete chlorosis (Msikita *et al.*, 2000). Cassava green mite is small and has a very mimetic green colour so that often it can only be seen with a hand lens. Mutisya *et al*. (2015) reported that acaricide, abamectin, was the most efficacious in controlling CGM compared with the effectiveness of the predatory phytoseiid, *Typhlodromalus aripo* (De Leon) and an insecticide, chlorpyrifos and fertilizer in the management of the pest. The fungus, *Neozygitis* cf. *floridana*, is parasitic on CGM in South America and may be considered for classical biological control of the pest in Africa (Oduor *et al.*, 1997). The most reliable and easy-to-adopt method of controlling these biotic stresses is the cultivation of resistant cassava cultivars (Ogbe *et al.*, 2003). Thus, the availability of high yielding and disease/ pests resistant cassava cultivars to farmers may be the most effective, long-term measure for sustainable production of the crop (Kueneman, 2002; Muhammad-Lawal *et al*., 2012).

The actual yield and the consistency of yield of an adapted cultivar in a particular environment is its ultimate index of adaptation, but yield is an outcome of several processes at all stages of growth and development of the crop. Therefore, assessment of adaptation based on evaluation of responses to biotic stresses, morphological and physiological/genetic performances of cultivars is of great importance. This study aimed at assessing the growth and yield performances as well as responses of five selected cassava cultivars to natural pest and disease pressures under a Southern Guinea Savanna ecological zone of Nigeria, with a view to identifying most adapted.

2. Materials and Methods

The experiment was conducted at the University of Ilorin Teaching and Research Farm, Ilorin, Nigeria. Ilorin is in the Southern Guinea Savanna agro-ecology and lies on longitude $4^0$35'E and latitude $8^0$30'N. The climate is characterized by dry and wet seasons, with an annual rainfall of about 1150 mm (Jatto and Ogunlela, 1988). The soil was slightly acidic and classified as a sandy loam alfisol of Tanke series. Two new cassava cultivars - TMS 92/0057 and TMS 92/0326 (selected for high yield and tolerance to some pests and diseases), TMS

92/30572 (a widely cultivated hybrid cultivar used as an improved check) were evaluated alongside two local checks: *Odongbo* and *Oko-Iyawo*. The land was ploughed, harrowed and ridged. The field layout was Randomized Complete Block Design with three replications. Each plot size was 30 m^2 comprising five ridges, each measuring 6 m long and 1m alley between plots. Inter and intra row plant spacing was 1×1 m from the crest of the ridges. Thus, a total of thirty cuttings per genotype were planted per plot. Weeds were controlled manually and by the use of chemical herbicide (glyphosate) as recommended. NPK 15-15-15 fertilizer was applied at the rate of

50 kg ha^{-1}.

Pest and disease severity symptoms were visually rated on the farm 12 months after planting (MAP). CMD severity scores were recorded on a 5-point scale; where 1 = No symptom observed; 2 = few discrete leaf mosaic (mild); 3 = moderate leaf mosaic; 4 = severe leaf mosaic; and 5 = very severe leaf mosaic. CBB severity scores were recorded on a 5-point scale according to Wydra (1994) where 1=no damage/infection; 2=mild damage/infection; 3=moderate damage/infection; 4=severe damage/infection and 5=very severe damage/infection.

CGM symptom severity was assessed on a 5-point scale thus: 1 = No symptom observed; 2 = few chlorotic specks on the leaf petioles and internodes (mild); 3 = moderately shortened bunchy top; 4 = severe bunchy top, plant becomes stunted and 5 = very severe bunchy top, stunted growth, induced shoots branches that are stunted, occasional death of plant top.

Data on plant height, number of leaves/plant, number of branches/plant at 12 months after planting (MAP) were collected. Reproductive parameters assessed included yield and yield components as follows: tuber yield ha^{-1}, length and width of tuber, weight of tuber and number of tuber/plant. Data were subjected to analysis of variance (ANOVA) using SAS 20.1. Significant mean values were ranked using Duncan`s new multiple range test ($p<0.05$) to determine the relative performance of the cultivars. The data were also subjected to correlation analysis to evaluate the relationship among the traits observed.

3. Results and Discussion

TABLE 1: Main effect of cultivars on mean severity of cassava mosaic disease (CMD), cassava bacterial blight (CBB) and cassava green spider mite(CGM) at 12 MAP.

Cultivars	CMD	CBB	CGM
TMS 92/0057	1.5[b*]	1.3[b]	3.4[b]
TMS 92/0326	1.6[b]	2.4[a]	2.6[c]
TMS 92/30572	1.2[b]	1.6[b]	4.6[a]
Odongbo	3.3[a]	1.6[b]	2.4[c]
Oko-Iyawo	1.6[b]	2.7[a]	2.5[c]
SE±	0.2	0.1	0.2

Means followed by different letters within the same column are significantly different at p=0.05 using Duncan`s new multiple range test

TABLE 2: Main effects of vegetative growth parameters of five cassava cultivars evaluated

Cultivars	Mean Plant height (m)	Mean number of stems/ cutting	Mean number of branches/ plant	Mean number of leaves/plant
TMS 92/0057	2.10	2.40	7.7[b]	199.8[a]
TMS 92/0326	1.97	1.83	3.5[c]	139.1[b]
TMS 92/30572	1.90	1.90	16.8[a]	230.1[a]
Odongbo	1.70	1.60	4.8[c]	150.7[b]
Oko-Iyawo	1.50	1.90	3.4[c]	86.5[c]
SE±	0.2	0.2	0.8	16.2

Means followed by different letter within the same column are significantly different at p=0.05 using Duncan`s new multiple range test

TABLE 3: Effect of cultivar on yield and yield components for five cassava cultivars evaluated

Genotypes	Yield/ha (tons)	Mean length of tuber (cm)	Mean mid-width of tuber(cm)	Mean weight of tuber (kg)	Number of tuber/plant
TMS 92/0057	41.7 [c]	41.0[a]	8.3[a]	2.7[d]	3.0 [b]
TMS 92/0326	62.0 [a]	45.5[a]	7.8[ab]	4.0[a]	3.8 [ab]
TMS 92/30572	54.2 [b]	42.5[a]	7.6[ab]	3.5[ab]	4.7 [a]
Odongbo	45.3 [c]	43.5[a]	7.7[ab]	2.9[d]	3.1 [b]
Oko-Iyawo	52.6 [b]	35.8[b]	6.2[b]	3.4[bc]	3.5 [ab]
SE±	6.8	1.6	0.3	0.4	0.3

Means followed by different letter within the same column are significantly different at p=0.05 using Duncan`s new multiple range test

Table 4: Correlation coefficient (r) of evaluated parameters of selected Cassava cultivars

	PH	NS	NB	NL	NT	WT	AWT	ALT	SMI	MVI	BBI
PH	-	0.3	0.3	0.5	0.2	-0.1	0.8*	0.5	0.3	-0.3	-0.2
NS		-	0.1	0.3	0.0	0.0	0.3	0.2	0.2	-0.4	-0.4
NB			-	0.8*	0.6*	0.0	0.2	0.1	0.9*	-0.4	-0.6*
NL				-	0.4	0.0	0.6*	0.5	0.7*	-0.2	-0.7*
NT					-	0.8*	0.0	0.3	0.4	-0.6*	0.0
WT						-	0.0	0.3	-0.1	-0.4	
AWT							-	0.7*	0.2	-0.1	-0.4
ALT								-	0	0.1	-0.1
SMI									-	-0.5	-0.4
MVI										-	-0.1
BBI											-

Legend: Legend: PH = Plant height

NS = Number of stems NB = Number of branches

NL = Number of leaves NT = Number of tuber per plant

WT = Weight of tuber per plant AWT = Average mid-width of tuber

ALT = Average length of tuber SMI = Spider Mite Index

MVI = Mosaic virus Index BBI = Bacterial blight Index

There were significant differences in disease and pest responses of the five cassava cultivars evaluated in this study (Table 1). Severity of damage caused by CMD, CBB and CGM varied significantly among cultivars. Symptom expression of CMD was significantly ($p<0.05$) higher with the local check, *Odongbo* (3.3) than other cultivars while TMS 92/30572 was the least susceptible (1.2). Symptoms expression of CBB was highest on '*Oko-Iyawo'* which was not significantly different from TMS 92/0326. The expression of symptoms of CMD and CBB was lowest on TMS 92/30572 and TMS 92/0057 respectively. The CGM severity of damage in TMS 92/30572 was significantly ($p<0.05$) higher than other cultivars. CGM symptoms was most severe on TMS 92/30572 (4.6) and moderately severe on TMS 92/0057 (3.4). A mild damage by the CGM was recorded on '*Oko-Iyawo'* and '*Odongbo'* (2.5) which was at par with TMS 92/0326.

Table 2 shows the main effect of cultivar on growth parameters of cassava plants. The effect of cultivar on the growth parameters evaluated was not significantly different for plant height and number of stems/cutting. However, number of branches/plant and number of leaves/plant elicited significant differences ($P<0.05$). Mean plant height ranged from 1.50m for '*Oko Iyawo'* to 2.10m in TMS 92/0057. Similarly, there was no significant difference on mean number of stems/plant. Mean number of stems/plant was between 1.6 in *Odongbo* and 2.4 in TMS 92/0057. TMS 92/30572 had the highest number of branches/plant (16.8) followed by TMS 92/0057 (7.7). The least number of branches/plant was recorded in the local checks, *Oko-Iyawo* (3.4) and *Odongbo* (4.8) which was similar to TMS 92/0326 (Table 2). The highest mean number of leaves/plant (230.1) was obtained from TMS 92/30572 which was statistically similar to TMS 92/0057 while the least number of leaves was recorded on *Oko-Iyawo* (86.5).

Table 3 shows the variations in yield and yield components among cassava cultivars evaluated. The main effect of cultivar on tuber yield/ha, mean length of tuber, mean mid-width of tuber, mean weight of tuber/plant and number of tubers/plant were significant at $p=0.05$. Genotype TMS 92/0057 produced the least number of tubers/plant which translated to the lowest tuber yield/ha. The mean length of tubers and mean mid-width of tubers varied with cultivars. TMS 92/0326 gave the highest yield/ha which was significantly different TMS 92/30572 in spite of the latter`s higher number of tubers.

Results of the correlation analysis revealed that only mean mid-width of tuber correlated significantly with plant height and mean length of tuber (Table 4). None of the measured parameters correlated significantly with the number of stems at both p=0.01 and p=0.05. Number of branches/plant gave a positive and significant ($P<0.05$) relationship with the number of leaves/plant, tubers/plant and cassava green mite. However, a significant but negative correlation was recorded for mosaic virus and bacterial blight diseases. Number of leaves had significant and positive relationship with number of branches; average mid-width of tuber and cassava spider mite but the correlation with bacterial blight was negative although significant. Number of tubers/plant had significant and positive relationship with number of branches/plant and weight of tubers/plant but a significant and negative correlation for cassava mosaic disease (Table 4). Weight of tubers/plant was positively correlated with number of tubers/plant and negatively correlated with cassava mosaic disease.

The yield of a particular cultivar could be a function of its growth parameters and susceptibility to pests and diseases. TMS 92/0057 had the least yield/ha but moderate infestation by CGM and few symptoms of cassava mosaic disease (CMD) and cassava bacterial blight (CBB). CGM was a problematic pest of cassava in this study as it showed moderate infestation on TMS 92/0057 and severe infestation on TMS 92/30572. The cultivar with the least yield (TMS 92/0057) could be considered as being susceptible to CGM. TMS 92/30572 had high yield but was most susceptible to CGM, thus it could not be recommended for locations where the pest is prevalent. Cultivar such as TMS 92/0326 recorded high harvestable tuber/ha and low pest/disease severity scores, suggesting that it could be recommended for release to farmers in the agro-ecology zone.

The study showed that host plant resistance could be adopted as an alternative means to the control of pathogens and pests instead of using synthetic insecticides. Nukenine *et al.*, (2002) reported that varietal resistance of cassava had a significant effect on the population growth rates of *M. tanajoa.* Cassava mosaic disease and cassava bacterial blight have been reported to be most important cassava diseases in Africa (Zhou *et al*., 1997) capable of causing an estimated 50% root yield reduction (Akparobi *et al*., 1998). It was observed that genetic variations among the improved genotypes and the local checks formed the basis for differential responses to growth parameters and yields. Baiyeri and Aba (2005) suggested that selection of cultivars possessing durable genes for resistance to these diseases portends sustainable way of enhancing cassava productivity. Fanou *et al.* (2001) reported that control of bacterial blight could be achieved by means of Integrated Control strategies which should comprise of improved cultural methods, crop rotation, resistant cultivars and quarantine measures to prevent introduction of highly aggressive strains to areas with low or no infection. Based on this study therefore, 'TMS 92/0326' was found to be the cultivar which possesses durable resistance to disease and pest pressure and could be considered as most suitable for enhanced cassava production in the study area.

4. Conclusion

Results from this study showed that the improved Cassava cultivars were generally better in terms of symptom expression of Cassava mosaic disease and Cassava bacterial blight than the local checks. The two local checks had significant yield reduction as a result of their high vulnerability to the CMD and CBB as further indicated by the significant negative correlation between CMD and number and weight of tuber. However, further improvement of the new cultivars would still be necessary particularly, if they were to be grown in areas with high incidence of CGM. Hence, the study concluded that 'TMS 92/0326' which recorded high harvestable tuber/ha and low pest/disease severity scores, indicated its suitability for large scale production in the study area and that this cultivar could be recommended to farmers in the studied agro-ecological zone.

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