



Effects of Fertilizer on the Quality and Quantity Cassava Yield in Niger State, Nigeria

A.A. Agboluaje, A.Y. Ismaila, B.Y. Aliyu, J.I. Galadima, A. Abubakar, A. Ma'ali, I. Musa and T.A. Muhammad

Department of Mathematical Sciences, IBB University, Lapai, Nigeria

ABSTRACT

The objective of the study is to assess the quantities/kilograms per acre of fertilizers used on different varieties of cassava for its yields. Regression models, Pearson correlation, Analysis of Variance (ANOVA), Chi-Square and T-Tests were the approach used. In regression models of Bida and NCR005 varieties, Replication II (RII) decreased in yields as different quantities of fertilizers per acre were used. In model of NCR006 variety, Replication (RI) decreased in yields as the same quantity of fertilizers were used. In model of NCR006 variety, RII increased in yields as the same quantity of fertilizers were used per acre. The cassava varieties of Bida, NCR005 and NCR007 with RI and RII having very strong positive relationship values as different quantities of fertilizers were used per acre for the cassava yields. NCR006 variety has moderate relationship between treatment and RII with the application of same quantity of fertilizers per acre. The cassava varieties of Bida and NCR007 with treatment-RI and treatment-RII were significance as the different quantities of fertilizers were used for cassava yields per acre. Therefore, the farmers have to choose the cassava varieties to plant with the right quantities of fertilizers application per acre for optimum yields.

Keywords: Bida, Cassava variety, Chi-square, Optimum yields

INTRODUCTION

The main objective of Agriculture Research Institute is to embark on farming activities which includes solving the problem of cereal crops such as Maize grain, Legume and Cassava throughout Nigeria which started in 1975. The National Cereal Research Institute (NCRI) as a directive development to shift crops to Rice, Beni seed, Soya bean and cassava. In other to have the quality and quantity of good production of crops like cassava, the right type of nutrient to augment the soil is necessary. What improves the productivity of the crop (like cassava) in the soil is the right requirement of fertilizer applications (Howeler, 1981).

Cassava (*Manihot esculenta* Crantz) can survive in poor soil and withstand climatic conditions to have sensible yields. Manure application can support cassava production profitability for longer period in poor soils (Mariscal, 1984). The poor soil can retain some fertility for longer time when quantities of nitrogen (N), phosphorus (P) and potassium (K) are employed for the increase of the cassava yields (Mariscal, 1984; Adiele et al. 2019). Bussari and Gana (2001) argued that

the impact of compost manure has added to the yield of the cassava.

In respect of food security, cassava utilization as food has promoted and encouraged the accomplishment of food diversification. Cassava is a nutritious food which is tolerance to drought, soil pH, low nutrient levels (Chavez et al. 2000). Cassava production is low.

Fertilizers are required as additional soil ingredients to improve the soil fertility where needed for high production of cassava. Organic and inorganic fertilizers are required depending on the soil nutrient composition for better soil management (Roy *et al.* 2006). Different combination of organic and inorganic fertilizers revealed high yield of cassava production in Indonesia (Dermiyati, *et al.* 2015).

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Address Correspondence to:

ayo_dele1960@yahoo.com,

Cassava flour contains gluten which exist in wheat flour, this has made Cassava (*Manihot esculenta* Crantz) to be multipurpose crop that meet the food challenges of developing countries, the global economy trend and climate change challenges [Food and Agricultural Organization (FAO), 2013]. Cassava flour mixtures are employed for bakery products and bakery products consumption have increased due to urbanization and more Food industries (Chakrabarti, Poonia & Chauha, 2017). Africa has been one of the major producers of cassava as second major food source (Biratu, Elias, Ntawuruhunga & Sileshi, 2018).

The age of cassava is inclined by Cassava Darker Streak Illness (CBSD) and African Cassava Mosaic Sickness (ACMD) (Boansi, 2017). Adetoro, Ogunbayo and Akinwale (2018) argued that with respect to disease resistance all the clones assessed were resistant to Cassava Mosaic Disease (CMD) and Cassava Bacterial Blight (CBB) vector infection and to the spread of the pathogen within the plant. In the Northern regions of Mozambique, the production of cassava is very low because of the attack of CBSD disease alone.

To satisfy home and business for cassava-based bread adventures needs, there is a prerequisite for research to adjust the yield gap through work on improved cultivation and planting material including; choosing readiness rates to offset low soil readiness, and surveying the cassava regard chain including transport from the farm to the town. When the right type of fertilizers is not applied to the soil, there are decrease in the cassava yields (Howeler, 1981; Ezui *et al.*, 2016).

Cassava can yield well on either fertile or none fertile land as revealed by most primitive farmers, even in a depleted soil (Obisesan, 2013). Now cassava cannot have maximum yields because the soil is not fertile enough to sustain it in some geographical areas in Nigeria (Adeleye & Ayeni, 2010).

Akinbani and Ayeni (2019) concluded that poultry manure and wood ash activate the fertility of none fertile soil for better cassava yields in Ondo, Nigeria.

Six different approaches (Regression models, Pearson correlation, Analysis of Variance

(ANOVA), Chi-Square, One Sample T-Tests and Paired samples T-Tests) are employed, which have not been discovered in the literature for optimum cassava yields.

METHODOLOGY

The data is collected from National Cereal Research Institute (NCRI) [Source: Michael Yisa Ndayagi, National Cereal Research Institute (2015) Badeggi] Niger State, Nigeria. The regression equation follows.

Regression Equation

Let $y = ax + b$ (1)

Reproduce equation (1) by x (2)

$yx = ax^2 + bx$ (2)

Summation of equations (1) and (2) (3)

i.e. $\sum y = a \sum x + nb$ (3)

$\sum yx = a \sum x^2 + b \sum x$ (4)

Reproducing equation (3) by $(\sum x)^2$ and (4) by, $\sum x$, then

$\sum y(\sum x)^2 = a \sum x(\sum x)^2 + nb(\sum x)^2$ (5)

$\sum yx \sum x = a \sum x(\sum x)^2 + b(\sum x)^2$ (6)

Take away equation (6) from equation (5) then,

$$\begin{aligned} \sum y(\sum x)^2 - \sum x \sum yx &= nb(\sum x)^2 - b(\sum x)^2 \\ b(n(\sum x)^2 - (\sum x)^2) &= \sum y(\sum x)^2 - \sum x \sum yx \\ b &= \frac{\sum y(\sum x)^2 - \sum x \sum yx}{n(\sum x)^2 - (\sum x)^2} \end{aligned} \quad (7)$$

Substitute for the value of b in equation (3)

$$\begin{aligned} \sum y &= a \sum x + n \left[\frac{\sum y(\sum x)^2 - \sum x \sum yx}{n(\sum x)^2 - (\sum x)^2} \right] \\ a \sum x &= \sum y - n \left[\frac{\sum y(\sum x)^2 - \sum x \sum yx}{n(\sum x)^2 - (\sum x)^2} \right] \\ a \sum x &= \sum y - \frac{n \sum y(\sum x)^2 - n \sum x \sum yx}{n(\sum x)^2 - (\sum x)^2} \\ a \sum x &= \frac{n \sum y(\sum x)^2 - \sum y(\sum x)^2 - n \sum y(\sum x)^2 + n \sum x \sum yx}{n(\sum x)^2 - (\sum x)^2} \\ a \sum x &= \frac{n \sum x \sum yx - \sum y(\sum x)^2}{n(\sum x)^2 - (\sum x)^2} \\ &= \frac{n \sum x \sum yx - \sum y(\sum x)^2}{\sum x [n(\sum x)^2 - (\sum x)^2]} \\ a &= \frac{n \sum yx - \sum y \sum x}{n(\sum x)^2 - (\sum x)^2} \end{aligned} \quad (8)$$

Correlation coefficient

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[n \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}} \quad (9)$$

Table 1: Analysis of Variance

Variation	Degree of Freedom	Mean Square	F	P-Value
Between treatments, $V_B = b \sum_j (\bar{x}_j - \bar{x})^2$	a - 1	$\hat{S}_B^2 = \frac{V_B}{a-1}$	$\frac{\hat{S}_B^2}{\hat{S}_W^2}$ with a - 1 and a(b - 1) degree of freedom	
Within treatments, $V_W = V - V_B$	a(b - 1)	$\hat{S}_W^2 = \frac{V_W}{a(b-1)-1}$		
Total, $V = V_B + V_W$	ab - 1			

V is the total variation, V_B is the variation between treatments, V_W is the variation within treatments, \bar{x} is the mean of the observations, S is the standard deviation, a is the total number of treatments and b is the total number of replications.

Chi-Square Test

The statistic is

$$\chi^2 = \frac{NS^2}{\sigma^2} = \frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \dots + (x_N - \bar{x})^2}{\sigma^2} \quad (10)$$

The Greek letter chi is χ^2 and “chi-square” reads χ^2

N is the total number of observations, \bar{x} is the mean of the observation, σ^2 is the variance and the numbers of observations is X_N

T-Test

The statistic is

$$t = \frac{\bar{x} - \mu}{s} \sqrt{N - 1} = \frac{\bar{x} - \mu}{s/\sqrt{N}} \quad (11)$$

\bar{x} is the calculate mean, μ is the assumed or hypothesized mean, S is the standard deviation and N is the total number of observations.

RESULTS AND DISCUSSION

The Cassava varieties that were used for experiment in this study were Bida, C0957, NCR005, NCR006 and NCR007 with the application of different quantities/kilograms (60, 120, 180, 240, 300)of fertilizers per acre. The average of all the cassava varieties was also considered.

Table 2 displayed that none of the coefficients of the independent variables and constant term weresignificance in the regression model of Bida variety with samequantity of fertilizersper acre being used for cassava yields. The regression model is

$$Y = 129.038 + 0.521x_1 - 0.356x_2$$

Y is the dependent variable, x_1 and x_2 are the independent variables which are replication I (RI) and replication II (RII) respectively. As RI yields were increasing, RII yields were decreasing with constant term 129.038.

Table 2 displayed that among all Cassava varieties employed for this study, only the regression model of NCR006 variety was significancewhich indicated thatdifferentquantities of fertilizers per acre were used forcassava yields. The regression model is

$$Y = 424.659 - 1.075x_1 + 0.366x_2$$

Y is the dependent variable, x_1 and x_2 are the independent variables which are replication I (RI) and replication II (RII) respectively. As RI yieldswere decreasing, RII yields were increasing with constant term 424.659.

Table 2: Coefficients of regression equations

model	Constant (B ₀)	Sig.	B ₁ RI	Sig.	B ₂ RII	Sig.
Bida	129.038	0.703	0.521	0.847	-0.356	0.879
C0957	1220.914	0.132	-0.4981	0.152	0.063	0.522
NCR005	1220.198	0.144	-4.146	0.750	-0.698	0.953
NCR006	424.659	0.007	-1.075	0.008	0.366	0.013
NCR 007	-37.068	0.813	-2.001	0.099	2.550	0.087
Average Cassava	298.545	0.190	-3.274	0.059	2.825	0.064

Note: RI is the replication I and RII is the replication II. B₁ and B₂ are the parameters.

Table 3: Pearson correlations sig.(2-tailed)

Cassava varieties	Treatment	sig	RI	sig	RII	sig
Bida						
Treatment	1.000	0.000	0.120	0.847	0.074	0.906
Replication I					0.943*	0.016
C0957						
Treatment	1.000	0.000	-0.886*	0.046	0.639	0.245
Replication I					-0.506	0.385
NCR 005						
Treatment	1.000	0.000	-0.836	0.077	-0.825	0.086
Replication I					0.980**	0.003
NCR 006						
Treatment	1.000	0.000	-0.748	0.146	0.543	0.344
Replication I					0.141	0.821
NCR 007						
Treatment	1.000	0.000	-0.044	0.944	0.349	0.654
Replication I					0.905*	0.035
Average cassava						
Treatment	1.000	0.000	-0.356	0.556	0.219	0.723
Replication I					0.813	0.094

** . Correlation is significance at the 0.01 level (2-tailed).

*. Correlation is significance at the 0.05 level (2-tailed).

Table 3 displayed that the all the cassava varieties used in this study, treatments have perfect positive correlation with treatments and all the cassava varieties used have RI very strong positive correlation with RII, expect C0957 and NCR006 which have RI strong negative and weak positive correlation with RII respectively. With Bida variety; treatment has weak positive correlation with RI, treatment has very weak positive correlation with RII. C0957, NCR005 and NCR006 varieties, treatments have strong negative correlation with RI and treatment have strong positive (negative) correlation with RII.

Table 4 displayed that the NCR006 variety was significance which indicated that the p-value is less than 0.05 level of significance and concluded that the cassava yields were improved based on the different quantities of fertilizer used. While the other five varieties were not significance and the fertilizers have the same effect on the yields of each variety.

Table 4: ANOVA table

Cassava varieties	F	Sig.
Bida	0.030	0.971
C0957	5.007	0.166
NCR 005	2.336	0.300
NCR 006	86.667	0.011
NCR 007	5.050	0.165
Average cassava	8.227	0.108

Table 5 displayed that in all the Cassava varieties; Chi-Square Tests have no significance difference between treatment and RI, and treatment and RII. This implied that the yields depended on cassava varieties with the same quantity per acre of fertilizers used.

Table 6 displayed that the T-Test of one-sample test revealed that the treatment in each cassava varieties were highly significance and concluded that there were significance effect on the cassava yields using different quantities of fertilizers, RI in each cassava varieties were significance. Only C0957 and NCR 006 varieties RII were not significance and concluded that there were no significance effect on the cassava yields when same quantity of fertilizers was used. While the other three RII

were highly significance and different quantities of fertilizers per acre were usedfor the cassava yields.

Table 5: Chi-Square Tests

Cassava varieties	Value	df	Asymptotic Significance (2-sided)
Bida			
treatment * RI	20.000	16	0.220
treatment * RII	20.000	16	0.220
C0957			
treatment * RI	15.000	12	0.241
treatment * RII	15.000	12	0.241
NCR 005			
treatment * RI	20.000	16	0.220
treatment * RII	20.000	16	0.220
NCR 006			
treatment * RI	20.000	16	0.220
treatment * RII	20.000	16	0.220
NCR 007			
treatment * RI	20.000	16	0.220
treatment * RII	20.000	16	0.220
Average Cassava			
treatment * RI	20.000	16	0.220
treatment * RII	20.000	16	0.220

Table 6:One-Sample T-TestTest Value = 0

Cassava varieties		t	Sig. (2-tailed)		t	Sig. (2-tailed)		t	Sig. (2-tailed)
Bida	treatment	4.243	0.013	RI	9.724	0.001	RII	9.090	0.001
C0957	treatment	3.600	0.013	RI	29.654	0.000	RII	2.078	0.106
NCR 005	treatment	4.243	0.013	RI	29.654	0.000	RII	26.84	0.000
NCR 006	treatment	4.243	0.013	RI	10.383	0.000	RII	4.481	0.110
NCR 007	treatment	4.243	0.013	RI	9.335	0.001	RII	11.03	0.000
Average cassava	treatment	4.243	0.013	RI	15.061	0.000	RII	13.96	0.000

Table 7 displayed that in Bidaand NCR 007 varieties; the correlation between treatment and RI, treatment and RII were weak and the paired samples tests revealed that there were significance effects of the fertilizers on the cassava yields, the correlation between RI and RII were very strong and the paired samples test revealed that there was no significance effects of the fertilizers on the cassava yields.

Table 7 displayed that in C0957, NCR 005 and NCR 006varieties; the correlation between treatment and RI, treatmentand RII were strong and the paired samples tests revealed that there wereno significance effects of the fertilizers on the cassava yields.In NCR 005variety the correlation between RI and RII were very strong and the paired samples test revealed that there

was significance effects of the fertilizers on the cassava yields, while in NCR 006 and C0957the correlation between RI and RII were very weak and moderate respectively and the paired samples test revealed that there was no significance effects of the fertilizers on the cassava yields.

Table 7 displayed that in Average cassavavariety; the correlations between treatment and RI, treatment and RII were weak and the paired samples tests revealed that there wereno significanceeffects of the fertilizers on the cassava yields, the correlation between RI and RII were strong and the paired samples test revealed that there was no significanceeffects of the fertilizers on the cassava yields.

Table 7: Paired Samples T-Test

	Cassava varieties	correlation	Sig.	t	Sig. (2-tailed)
pair	Bida				
Pair 1	treatment -RI	0.120	0.847	-3.486	0.025
Pair 1	treatment - RII	0.074	0.906	-3.639	0.022
Pair 1	RI - RII	0.943	0.016	-1.804	0.145
Pair	C0957				
Pair 1	treatment -RI	-0.886	0.046	-0.789	0.474
Pair 1	treatment - RII	0.639	0.245	-1.390	0.237
Pair 1	RI - RII	-0.506	0.385	-0.965	0.389
Pair	NCR 005				
Pair 1	treatment -RI	-0.836	0.077	-0.731	0.505
Pair 1	treatment - RII	-0.825	0.086	-0.599	0.581
Pair 1	RI - RII	0.980	0.003	3.890	0.018
Pair	NCR 006				
Pair 1	treatment -RI	-0.748	0.146	-2.326	0.081
Pair 1	treatment - RII	0.543	0.344	-2.545	0.064
Pair 1	RI - RII	0.141	0.821	0.008	0.994
Pair	NCR 007				
Pair 1	treatment -RI	-0.044	0.944	-3.474	0.025
Pair 1	treatment - RII	0.349	0.564	-4.740	0.009
Pair 1	RI - RII	0.905	0.035	-0.044	0.967
Pair	Average cassava				
Pair 1	treatment -RI	-0.356	0.556	-2.403	0.074
Pair 1	treatment - RII	0.219	0.723	-3.106	0.036
Pair 1	RI - RII	0.813	0.094	-0.526	0.627

Conclusion

The regression models in Table 2 displayed that in the model of Bida variety, RI increased in yields as same quantity per acre of fertilizers were used. In models Bida and NCR005, RII decreased in yields as same quantity per acre of fertilizers were used. In model NCR006, RI decreased in yields as the different quantities of fertilizers were used. In models C0957, NCR005, NCR007 and Average Cassava, RI decreased in yields as different quantities per acre of fertilizers were used.

The cassava varieties of Bida, NCR005 and NCR007 with RI and RII having very strong positive relationship values of 0.943, 0.980 and 0.905 respectively as different quantities per acre of fertilizers were used for cassava yields which was displayed in Table 3 NCR006 variety has moderate relationship between treatment and RII with the same quantity per acre of fertilizers.

The ANOVA Table 4 displayed that only NCR006 variety was significant by using the

same quantity per acre of fertilizers for cassava yields.

The cassava varieties of Bida and NCR007 with treatment-RI and treatment-RII were significant; different quantities per acre of fertilizers were used for cassava yields as displayed in Table 6. All the cassava varieties RI and RII were not significant, therefore, same quantity per acre of fertilizers were used for cassava yields as displayed in Table 7 of paired samples t-test. Chi-Square in Table 5 displayed that all the cassava varieties were not significant, therefore, same quantity per acre of fertilizers were used for cassava yields.

Therefore, the farmers have to choose the type of cassava varieties to plant with the right quantities per acre of fertilizers application for optimum cassava yields.

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