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Research Paper

Measuring Productivity of Garden Egg Using Organic Manure in Latin Square Experimental Design in Kontagora Local Government Area, Niger State, Nigeria

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ABSTRACT
The thrust of this study investigates the productivity of garden egg using organic manure in the experiment. The LSD was used as a measure to enhance local control through blocking. The experimental design consists of a $5\ x\ 5$ *rows and columns in the LSD so as to capture all factors causing variation in the experiment. The organic manure were divided in the lay out and arranged randomly using alphabetical letters which were also randomised in each block. The treatmentwise arrangement is in accordance with the organic manure treatment effect. The observed mean treatment allowed the estimation of the treatment sum square in order to enhance means comparison in the variance ratio or the analysis of variance (ANOVA) also known as F-test statistics. The critical difference (CD) was used as a modified t-test of significance. The estuation of the F-statistics as a variance ratio of the treatment mean square to the error mean square was 7.46 at* $\alpha_{0.05}$ *with* $12df$*. Hence, using oragnaic manure to determine the productivity of garden egg gave result that was significantly different. The CD analysis was used as modified t-test which showed a t-value of* 7.25 *at* $\alpha_{0.05}$ *with* $12df$ *indicating that the treatments differ significantly. It was recommended that extension agents should be involved in disseminating the role of organic manure to farmers. Also, government should institute policy frame work that will enhance adoption and of use organic manure by farmers and provision of adequate incentive to organic manure users among farmers by government and agro-service agencies to serve as encouragement for garden egg farmers.*
KEY WORDS: *Productivity, Garden egg, Organic manure, LSD, Experimental design, ANOVA.*

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I. INTRODUCTION

Leafy and fruit vegetables constitute the most affordable and sustainable source of micronutrients in diets in most parts of sub-Saharan Africa, especially, in the urban areas, they are therefore widely grown in the area (Anyaegbu, *et al* 2013). The name "Garden eggplant" was derived from the shape of the fruits of some varieties which are white and shaped like chicken eggs (Chen, Li and Kali, 2001). The plant *Solanumspp* is a vegetable with increasing popularity in the world (Pessarakli and Dris, 2003) Garden egg *Solanummelongena L* belongs to the *Solanaceae* family is a popular fruit vegetables in many parts of the world especially in parts of Africa, South-East Asia and Central America and in West Africa is probably the third most consumed vegetable in Nigeria and Ghana (Horna, Smale, Al-hassan, Falck-zepeda, &Timpo, 2008). The preference for fresh horticultural fruits and vegetables from sub-Saharan Africa by buyers across the world has been increasing in recent times (Anifori, 2010). The fruits are consumed fresh as snack, or used in the preparation of stew and soup while the leaves are precious herbs in some communities (Gajewski, Katarzyna, & Bajer, 2009). Fruits are harvested at the physiological maturity, (unripe) stage but usually before full-seed maturation.

The fruit of the plant comes in a wide array of shapes and colours, some are yellow and small with green stripes; while some are big yellow, also white colour and flat ribbed green types among others (Chen, Li, and Kail, 2001). The importance of the garden-egg cannot be over emphasized. It is consumed on daily basis by urban families and also represents the main source of income for producing households in West Africa (Danquah, 2000). Nutritionally, garden egg contains water (92.5%), protein (1%), fat (0.3%), and carbohydrates

(6%). They contain between 30 and 50% of iron (Fe), fiber, potassium (K), manganese (Mn), copper (Cu) and vitamins; thiamin (vitamin B_1), B_6, folate, magnesium and niacin. Egg plant also contains phyto-nutrients such as nasunin and chlorogenic acid (Sabo and Dia, 2009). It is a very good source of dietary fiber, potassium, manganese, copper and vitamin B_6, folate, magnesium and niacin. It is a valuable vegetable for canning industries for garden-egg paste; the fruit can be eaten raw or served as a baked, grilled, fried or boiled vegetable and can be used in stews. To the Igbos of South-eastern Nigeria, the fruit can be used as a substitute for kola nut (*Cola*sp) for entertaining visitors and plays a key role in ceremonies.

In this modern age individuals are becoming more and more aware of the effect that inorganic crop production has adverse effects on the environment, hence they are taking crucial measures to mitigate these environmental effects. Manure is an environmentally safe way to ensure enrichment of the soil with nutrients required for crops production (Eghball*et al*, 2002). In many agricultural systems, management of the nutrient system is very crucial and there ought to be a balance between the import as well as the export of nutrients within the system (Dauda*et al*, 2008). Manure plays a positive role in the nutrient balance as it

ensures minimal loss of nutrients in the system. It is also an important way of nutrient cycling since the large fraction of nutrient from the manure is taken up by crops (Schroder, 2005). Addition of organic manure significantly enhance growth, yield and fruit quality which is associated with the supply of essential nutrients by continuous mineralization of the soil and its favorable effect on physical and biological properties (Suge, 2011). Poultry manure contains nitrogen that is very essential for the growth of leaves, as it enhances vegetative growth which is very crucial, especially in plants where leaves are the source of food, for instance in case of cabbages and kales, Okokoh*et al*. (2011), it is a nutrient essential in the formation of the chlorophyll molecule, giving the leaf its deep green color. As chlorophyll increases, the rate of photosynthesis increases, hence the food is available to plants making it to have a high growth rate that consequently increases the leaf size of the plant (Eghball*et al*. 2002). Potassium is essential for carbohydrates formation that occurs in the leaves of plant through photosynthesis, consequently increasing the leaf size (Pezzolla*et al*, 2013).The area devoted to the cultivation of the crop globally is about two million hectares (FAO; 2007). With the growing consumption of garden eggs, there is a need to ensure high quality fruits with minimal or no sacrifice of quality.

Statement of problem

As an annual crop, Eggplant will require high quantity of nutrients to sustain its growth .Soil fertility defines the status of soil with regards to its ability to supply nutrient elements essential for healthy plant growth. These nutrients can easily be made available through the use of organic or inorganic fertilizers but there are problems associated with its use which include: leaching, soil degradation, underground water pollution, fast release of nutrients. Organic manure application is known to supply plant nutrients and improve the soil structure. In order to obtain high yield of garden eggs there is the need to augment the nutrient status of the soil to meet the crop's requirement and thereby maintaining the fertility status of the soil. One of the ways of increasing the nutrient status is by boosting the soil nutrient content either with the use or organic materials such as poultry manure (PM), other animal waste, or with the use of compost with or without inorganic fertilizers (Dauda, Ajayi and Ndor, 2008). Vegetables cultivated by using organic manure are gaining popularity because of less chemical residues and better taste of the fruits. Considering the adverse effects on soil health and the environment, the use of inorganic fertilizers is not advisable especially for vegetables because of chemical residue problems. In addition, fertilizers are scarce, beyond the reach of resource poor farmers, their continuous application results in soil acidity, degradation of soil properties and pollution of ground water. In any case, the expected yields of crops are sometimes not realized by using inorganic fertilizers due to leaching because of high rainfall and low activity clays in these soils in southern guinea savanna (Ano and Agwu 2005).. Poultry manure is relatively resistant to microbial degradation. However, it is essential for establishing and maintaining the optimum soil physical condition for plant growth. Poultry manure is also very cheap and effective as a good source of nitrogen (N) for sustainable crop production, but its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of resource-poor farmers due to its high cost (Rahman, 2004). The broad objective of this study is to valuatethe productivity of garden egg *Solanummelongena*using organic manure in LSD experimental designin the study area.

Research Objective

The specific objective is to measure the productivity of garden egg using organic manure in the study area.

Research Question

What is the level of productivity of garden egg using organic manure application in the study area?

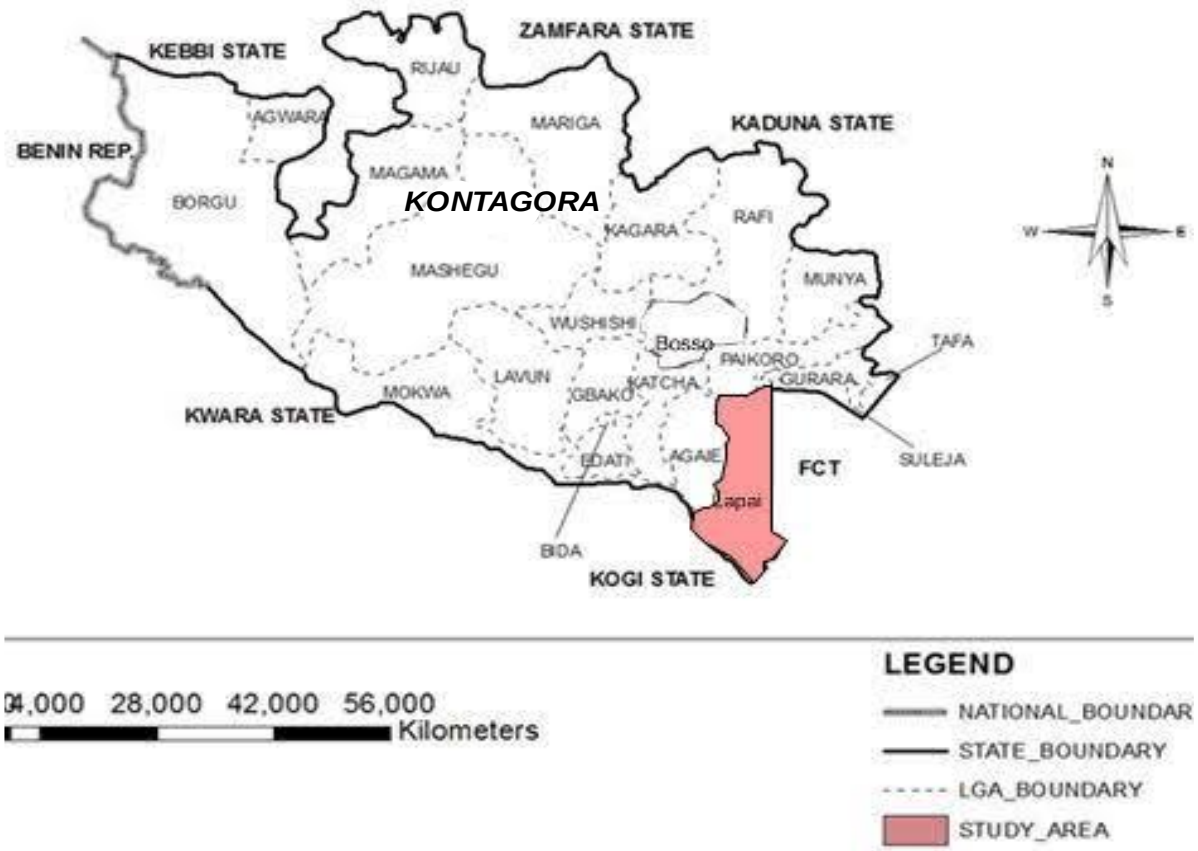
Research hypothesis

For the successful completion of the study, this research hypothesis was formulated and tested by the researcher;Ho: There is no significant difference in the productivity of garden eggusingorganic manure application in the study area.

Methodology

The Study Area

Niger State Map



Source: Google Map 2019

The field experiment was conducted at the orchard of Research Farm of the department of Agricultural Education, Federal College of Education, Kontagora. Niger State. Kontagora is located at an elevation of 335 meters above sea level and has a population of 98,754. Its coordinates are 10°24'1" N and 5°28'11" E in DMS (Degrees Minutes Seconds) or 10.4003 and 5.46972 (in decimal degrees). Its UTM position is GM 75 and its Joint Operation Graphicsreference is NC 31-08.

Source: National Population Commission of Nigeria (web), NationalBureau of Statistics (web) 2019

Choice of Site and Experimental Design

The project work was carriedout in the departmental orchard at a lower open place and the soil is loamy. The land preparation commenced with the initial removal of all the shrubs and grasses which were later burnt on the 15th June, 2019. The construction of beds was carried out using measuring tape and hoe. Before the beds were constructed, the plot was measured. Five beds of size 1m wide and 1m long each was constructed. In the design of experiment, the experimental material was divided into rows and column and the treatment were allocated such that each treatment occurs only once in a row and once in a column. This type of design is called Latin Square design (LSD). In LSD, the number of rows and columnare equal. Hence, the arrangement forms a square in each row and each column is a complete block or replication.

Data Collection

Data were collected at harvest based on the yield per bock or replications. These were weighed and the mean value recorded per block to give a total data points of 25 as seen from the rows and columns presented in table 1.

II. DATA ANALYSIS

All the data collected from each block of experimental layout were analyzed using F-test statistics and the critical difference (CD) or the least significant difference (LSD) analysis. These were used in the test of significance from where statistical inference were made based on the result of data analysis.

1. Theoretical framework

The Latin square design LSD which was used in the experiment consists of equal number of rows and column. The experimental material consisting of poultry droppings and cow dung as organic manures were divided into five levels in rows and columns and the treatments were allocated such that each treatment occurs only once in a row and in column of blocks or replications known as Latin square design LSD. This is called 5×5 LSD to give a total of 25 blocks.

The essence of LSD is to enhance local control through blocking with the assumption that a field will have different fertility gradient running along and across the farm where the experiment was carried out. This will enhance the achievement of local control so that most factors causing variation will be properly captured.Therefore, the LSD is a simple way required to forestall local control and enhance efficiency and accuracy in the experimental design. The blocks were allocated to treatment materials using five different levels of organic manures which were placed in the blocks to determine productivity of garden egg contributing to variation in responses to treatments in the experimental units.

In the experiment, the organic manures were divided in the layout and arranged randomly using alphabetical letters which were randomized. This is shown in table 1. The treatmentwise arrangement is shown in table 2, which is in accordance with the organic manure treatmentwise effect in alphabetical order. This will enhance the estimation of the treatment sum of squares in order to give room for means comparison in the variance ratio or the analysis of variance (ANOVA) also known as F-test statistics .

2. The Model

The Method of Analysis (ANOVA) model also known as F-test statistics was used to analyse the result obtained in order to compare the means in the variance. The F- test is also known as variance ratio.

The ANOVA model for the LSD that was applied takes a linear relationship of this form;

$Y_{ijk} = \alpha_0 + r_i + c_j + t_k + e_{ijk}$ ---------- 1

$Where,\ Y_{ijk} = Output\ effect\ or\ yeild.$

$$\alpha_0 = Interpret\ term$$
$$r_i = i_{th}\ row\ effects$$
$$c_j = j_{th}\ column\ effects$$
$$t_k = k_{th}\ treatment\ effects$$

Also, let $R_i = i_{th}\ row\ total$

$$C_j = j_{th}\ column\ total$$

$Tk = k_{th}\ treatment\ total$

The different sums of squares for the 5 x 5 LSD can be obtained as follows:

$CF = \frac{(GT)^2}{t^2}$ ---------- 2

Where, CF = Correction factor.

GT = grand total

t^2 = Square of the treatment effect.

Hence,

Total SS $= \Sigma y_{ijk}^2 - CF$ ---------- 3

Row SS $= \frac{1}{t}\Sigma R_i^2 - CF$ ---------- 4

Column SS $= \frac{1}{t}\Sigma C_j^2 - CF$ ---------- 5

Treatment SS $= \frac{1}{t}\Sigma T_k^2 - CF$ ----------6

Error SS $= \left[\left(\Sigma Y_{ijk}^2 - CF\right) - \left(\frac{1}{t}\Sigma R_i^2 - CF\right) - \left(\frac{1}{t}\Sigma C_j^2 - CF\right) - \left(\frac{1}{t}\Sigma T_k^2 - CF\right)\right]$--- 7

The t-test statistics

The critical difference (CD) also known as least significant difference (LSD) was used as a modified t-test of significance in order to make statistical inference of the t-test with reference to the stated null hypothesis,

$CD = t.SE\ (d)$ ---------- 8

Where, CD = Critical Difference (t-test).

t = tabular value of t for a specified level of significance and error df.

SE (d) = Standard error

$SE(d) = \sqrt{\frac{2(EMS)}{r}}$ ---------- 9

Where, EMS = error mean square
r = number of rows.

Table 1 Garden Egg Yield

	d	a	e	b	c	Total	
	38.0	24.1	25.1	38	41.2	166.4	
	E	b	c	d	d		
	21	37.1	25	30	32.1	153.7	
	c	e	b	d	a		
	34.6	34.5	38	39.8	25	172.2	
	a	c	d	e	b		
	31.8	30.1	47.7	28	43.9	182.2	
	b	d	e	a	e		
	43.3	30.6	40.1	35.9	24.6	165.7	
Total	168.9	156.4	176	172.1	166.8	840.2	GT.

Table2. Treatmentwise arrangement of the result

	A	b	c	d	e
	24.1	38	41.2	38	25.1
	25	37.1	33.3	32	21.1
	25.2	38.1	34.6	39.8	34.5
	31.8	43.9	30.1	47.7	28
	27.3	43.3	40.1	30.6	24.4
Total	133.4	200.4	184.3	188.2	133.8
Mean	26.68	40.08	36.86	37.46	26.76

III. RESULTS AND DISCUSSION

The row sum of squares (RSS), column sum of squares (CSS) and treatment sum of squares (TSS) were 86.3224kg, 43.522kg and 811.3364kg respectively while the Total Sum of Square (TSS) was 1267.55846kg. Also, the row mean squares (RMS), column mean square (CMS),treatment mean square (TMS) and Error Mean Square (EMS) were 21.56kg,10.88kg,202.83kg and 27.20 respectively.

The estimation of the F-Statistics or (ANOVA) as a variance ratio of treatment mean square to the Error Mean Square (EMS) was 7.46at$\alpha_{0.05}$with 12 df. This indicates that the treatment using organic manure to determine the productivity of garden egg in the LSD gave a result that is different significantly in the experiment.The computation of the t-test statistics was used by applying the Critical Difference (CD) analysis.The table value of t for $\alpha_{0.05}$ and at $12df$ is 2.179 while the SE (d) was3.33. Hence, the CD value is a product of the table value and SE (d). The CD value was 7.25 at $\alpha_{0.05}$at$12df$. This result shows that the treatment differs significantly. See table 3.

Table 3: Analysis of Variance Table

$Source\ of\ Variation$	df	SS	MS	F
$Rows$	4	86.224	21.56	$0.79 < 1$
$Columns$	4	43.5224	10.88	$0.40 < 1$
$Treatment$	4	811.3364	202.83	7.46^{**}
$Error$	12	326.3772	27.20	
$Total$	24	1267.46		

$** = P < 0.05$

Test of hypothesis for the productivity of garden egg to organic manure application

Test of hypothesis of the productivity of gardenegg to organic manure application was carried out using the result of analysis based on the objective of the study.The null hypothesis states that "there is no significant difference in the productivity of garden egg using organic manure in the experiment, that is,$H_0: H_i = X_i = 0$. The result of the analysis shows that the calculated F-value of7.46 was significant at $\alpha_{0.005}$ level of significance and $12df$. Hence, the null hypothesis was rejected. This implies that there is significant difference between yield of garden egg (Y_i) and organic manure (X_i) application in the study area. See table 4.

Furthermore, the t-test statistics using the (CD) or (LSD) was calculated. The result showed that t-value of 7.25 was above the t-critical value of 2.179 and the result was significant at $\alpha_{0.05}$ level of significance. Hence, there is significant difference in the yield of garden egg using organic manure in the study area. Since the hypothesis that "there is no significant difference between garden egg yield and organic manure application" was rejected, there are some implications that can be deduced for production planning and investment in garden egg production in the study area.

Table 4: Test of hypothesis for the productivity of garden egg using organic manure in an LSD experimental design.

	Null Hypothesis	Critical t-value	SE(d)	Calculated t-value CD or LSD	Decision
Yield function	$Y_i = 0$	2.179	-		
	$X_i = 0$	-	3.33		
		-	-	$(2.179)(3.33)$	
	$Y_i = X_i = 0$			7.35^{**}	Reject H_0

$** = P < 0.05$

IV. RECOMMENDATIONS

The study revealed that the productivity of garden egg was significant using organic manure in its production The result of this study can be adopted and utilized by farmers to improve on their level of productivities and the income accruing to them. It is in this regard that these policy measures were proffered.

i. There should be an institution of policy framework by government that will enhance farmers in adopting and utilizing organic manure application as a technological package in garden egg production.

ii. Extension agents should be involved in disseminating the rule of organic manure application to farmers in the production of the garden egg. This will serve as as basis in increasing productivity among the farmers.

iii. There should be provision of adequate incentive by government and other agro-service agencies for organic manure users among farmers producing garden egg. These incentives are needed as sources of encouragement enshrined in prompt delivery of other inputs required in production among farmers.

V. CONCLUSION

These study started on the note that leafy and fruit vegetables such as garden egg constitute the most affordable and sustainable source of micro nutrients in most diets. The productivity of garden egg was determined using organic manure in the experiment. The experiment involved application of Latin square (LS) experimental design. The result of analysis of variance (ANOVA) and critical difference analysis (CD) showed that the productivity of garden egg was significant and satisfactory. It was on this basis that some policy measures that we further enhance improvement and performance of garden egg production among farmers were suggested.

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