International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 12
August 2016

Application of Randomized Completely Block Design to The Yield of Maize

[1]Ogunsanya B.G. [2]Sulaimon Mutiu O.

[1,2]*Department of Statistics & Mathematics*
Moshood Abiola Polytechnic, Abeokuta, Ogun State, Nigeria.

[1]ogunsanya.busuyi@mapoly.edu.ng [2]mtsulaimon@gmail.com

ABSTRACT

This study examined the significant difference in the mean yield of maize in Ogun State, Nigeria with respect to the effect of fertilizer's proportion and maize varieties. For the successful execution of this research work, secondary data was collected from Ogun State Agricultural Development Programme (OGADEP), Department of Agriculture Production Survey (APS), Ogun State. There were four levels of fertilizer's proportion (50kg, 100kg, 150kg and 200kg) and three levels of maize variety (Open Pollinated, Hybrid and Local Maize). Data collected was analyzed electronically using SPSS version 21. The analysis techniques employed was a Randomized Completely Block Design (RCBD) without replicates. Results from the analysis revealed that there is significant difference in the effect of the fertilizer's proportions and maize varieties on the yield of maize in Ogun State, Nigeria. The multiple comparisons test for fertilizer proportion indicates the significant difference to be between 50kg & 200kg fertilizers and between 100kg & 200kg fertilizers. However, an evaluation of the marginal mean revealed the 200kg fertilizer to be the most suitable. The multiple comparisons test for maize varieties indicates the significant difference to be between Open pollinated and Hybrid maize. However, an evaluation of the marginal mean revealed the Hybrid type of maize to be the most suitable

Keywords: Application, Block, Completely, Design, Maize, Randomized, Yield.

INTRODUCTION

Experiment is a planned investigation aimed at deriving information upon which decision can be based. The importance of experiment is mostly used in the field of Agriculture and other biological related studies. It gives information about two or more phenomena under study. For instance, an experiment may be carried out on two or more levels of a particular fertilizer, to find out whether or not the mean yield of crops resulting from the application of these fertilizers are the same or different.

Experimental design refers to the statistical procedure of imposing certain treatment on subjects or material (unit) so as to be able to monitor the effect of these treatments on the units. Selection of an appropriate design is therefore of primary importance in the process of experimentation.

AIM AND OBJECTIVES OF THE STUDY

The aim of this research work is to examine the significant difference in the mean yield of maize in Ogun State with respect to the effect of fertilizer proportion and maize varieties.

The objectives are:

1. To investigate the significant difference in the effect of fertilizer proportion on the mean yield of maize in the state.

2. To investigate the significant difference in the effect of maize varieties on the mean yield of maize in the state.

SCOPE OF THE STUDY

This research work covers the application of Randomized Completely Block Design (RCBD) to the yield of maize in Ogun State, Nigeria, with fertilizer proportion taken as the design treatment and maize varieties taken as the block.

The data used is secondary in nature (year 2012/2013), extracted from the record of experiment conducted on the yield performance of varieties of maize with different proportion of NPK fertilizer.

There were four levels of fertilizer's proportion (50kg, 100kg, 150kg and 200kg) and three levels of maize variety (Open Pollinated, Hybrid and Local Maize).

RESEARCH HYPOTHESES

$H_{01}: \tau_i = 0 \quad ; \quad i = 1,2,3,4$

$H_{02}: \beta_j = 0 \quad ; \quad j = 1,2,3$

Where τ_i is the effect of fertilizer's proportion and β_j is the maize variety's effect.

LITERATURE REVIEW

Maize (*Zea mays* L) is one of the major cereal crops grown in the humid tropics and Sub-Saharan Africa. It is a versatile crop and ranks third following wheat and rice in world production as reported by Food and Agriculture Organization (FAO, 2002). Maize crop is a key source of food and livelihood for millions of people in many countries of the world. It is produced extensively in Nigeria, where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). In advanced countries, it is an important source of many industrial products such as corn sugar, corn oil, corn flour, starch, syrup, brewer's grit and alcohol (Dutt, 2005). Corn oil is used for salad, soap-making and lubrication. Maize is a major component of livestock feed and it is palatable to poultry, cattle and pigs as it supplies them energy (Iken *et al*., 2001). The stalk, leaves, grain and immature ears are cherished by different species of livestock (Dutt, 2005).

In spite of the increasing relevance and high demand for maize in Nigeria, yield across the country continues to decrease with an average of about 1 t/ha which is the lowest African yield recorded (Fayenisin, 1993). The steady decline in maize yield can be attributed to:

1. Rapid reduction in soil fertility caused by intensive use of land and reduction of fallow period as reported by Directorate of Information and Publications of Agriculture (DIPA, 2006).
2. Failure to identify and plant high yielding varieties most suited or adapted to each agro-ecological zone (Kim, 1997).
3. Use of inappropriate plant spacing which determines plant population and final yield (Zeidan *et al*., 2006).

Tolera *et al*., (1999) suggested that breeders should select maize varieties that combine high grain yield and desirable stover characteristics because of large differences that exist between cultivars. Odeleye and Odeleye (2001) reported that maize varieties differ in their growth characters, yield and its components, and therefore suggested that breeders must select most promising combiners in their breeding programmes.

Randomized completely Block Design

Probably the most frequently used design is the randomized completely block design (RCBD). The fundamental idea of the RCBD is to group experimental material together into homogeneous blocks. The object of this grouping is to keep the errors within each group as small as possible (Cochran and Cox, John Wiley & Sons, Inc., 1957). The randomized complete block design has several advantages:

- Using blocks of more homogeneous experimental material usually results in more accurate results than if a completely randomized design is used.
- Any number of treatments and any number of replicates (blocks) can be used. In the complete block design, every treatment will have the same number of replicates.
- Statistical analysis is straightforward.
- If the variance is larger for some treatments than others, an unbiased error for testing any specific combination of the treatment means can be obtained.

The only disadvantage to the RCBD comes when there are missing values. If an entire group (block) is missing or if data on an entire treatment are missing, there is no difficulty with the analysis. However, when some individual units are missing there can be some problems. There is a “missing-plot" technique that lets us use the available data to their fullest extent. One other caution with the RCBD, if there are not real differences among the blocks then blocking can actually cost us some precision in the estimate of error variability. This is due to the fact that blocking takes away degrees of freedom from the estimate of the error variation.

The model for the Complete Randomized Block Design is defined as:

$$y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$$
$$\varepsilon_{ij} \sim N(0, \sigma^2)$$
ε_{ij}'s independent

where

y_{ij} is the random variable representing the response for treatment i observed in block j

μ is a constant (which may be thought of as the overall mean)

τ_i is the (additive) effect of the i^{th} treatment $(i = 1, 2, \dots, k)$

β_j is the (additive) effect of the j^{th} block $(j = 1, 2, \dots, n)$

ε_{ij} is the random error for the i^{th} treatment in the j^{th} block.

METHODOLOGY

Techniques of data analysis

The analysis techniques employed is a Randomized Completely Block Design (RCBD) without replicates.

Method of data analysis

In analyzing the data for significant difference in the mean yield of maize, the RCBD model is partitioned into:

Sum of squares total, defined as:

$$SS_T = \sum_{i=1}^{k}\sum_{j=1}^{n}(y_{ij} - \bar{y}_{..})^2$$
$$= \sum_{i=1}^{k}\sum_{j=1}^{n} y_{ij}^2 - \frac{(y_{..})^2}{N}$$

with $N - 1$ degree of freedom

Sum of squares treatment (Fertilizer proportion), defined as:

$$SS_{trt} = n_j \sum_{i=1}^{k}(y_{i.} - \bar{y}_{..})^2$$
$$= \sum_{i=1}^{k}\left[\frac{y_{i.}^2}{n_j}\right] - \frac{(y_{..})^2}{N}$$

With $k - 1$ degree of freedom

Sum of squares block (maize varieties), defined as:

$$SS_{block} = n_k \sum_{j=1}^{n}(y_{.j} - \bar{y}_{..})^2$$
$$= \sum_{j=1}^{n}\left[\frac{y_{.j}^2}{k_i}\right] - \frac{(y_{..})^2}{N}$$

With $n - 1$ degree of freedom

And Sum of squares error defined as:

$$SS_E = SS_T - SS_{trt} - SS_{block}$$

The respective mean square is thereafter estimated as thus:

Mean square treatment, defined as:

$$MS_{trt} = \frac{SS_{trt}}{k-1}$$

Mean square block, defined as:

$$MS_{block} = \frac{SS_{block}}{n-1}$$

And Mean square error, defined as:

$$MS_E = \frac{SS_E}{(n-1)(k-1)}$$

Corresponding treatment and block F-ratio value is thereafter calculated thus:

$$F - \text{ratio}_{trt} = \frac{MS_{trt}}{MS_E}$$

and

$$F - \text{ratio}_{block} = \frac{MS_{block}}{MS_E}$$

The decision rule is to reject H_0 if:

*F-ratio $\geq F_{tabulated}$ - *Manually*

*Sig. value $\leq \alpha$ -*Electronically* (SPSS)

The level of significance was set at $\alpha = 0.05$.

The Tukey multiple comparisons test was further conducted for identified significant difference in effect of fertilizer proportions and maize varieties.

Fertilizer proportions and maize varieties were respectively coded into the SPSS data editor as thus:

1 = 50kg, 2 = 100kg, 3 = 150kg and 4 = 200kg. 1 = Open Pollinated, 2 = Hybrid and 3 = Local Maize.

DATA PRESENTATION

Table1: The yield performance of varieties of maize with NPK fertilizer proportion

	Rate of application per treatment kg/ha			
Varieties	50kg	100kg	150kg	200kg
Open Pollinated	1.12	1.06	1.35	2.39
Hybrid	1.32	2.43	3.14	5.14
Local maize	0.85	1.19	2.50	2.66

RESULT

Table 2: Between-Subjects Factors

		N
Fertilizer proportion	1	3
	2	3
	3	3
	4	3
Maize varieties	1	4
	2	4
	3	4

Table 3: Tests of Between-Subjects Effects (ANOVA)

Dependent Variable: Yield

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	66.999[a]	6	11.167	29.078	.000
Fertilizer proportion	9.097	3	3.032	7.897	.017
Maize variety	5.192	2	2.596	6.760	.029
Error	2.304	6	.384		
Total	69.303	12			

a. R Squared = .967 (Adjusted R Squared = .934)

Table 4: Estimated Grand Marginal Mean

Dependent Variable: Yield

Mean	Std. Error	95% Confidence Interval	
		Lower Bound	Upper Bound
2.096	.179	1.658	2.534

Table 5: Estimated Fertilizer proportions Marginal Mean

Dependent Variable: Yield

Fertilizer proportions	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.097	.358	.221	1.972
2	1.560	.358	.685	2.435
3	2.330	.358	1.455	3.205
4	3.397	.358	2.521	4.272

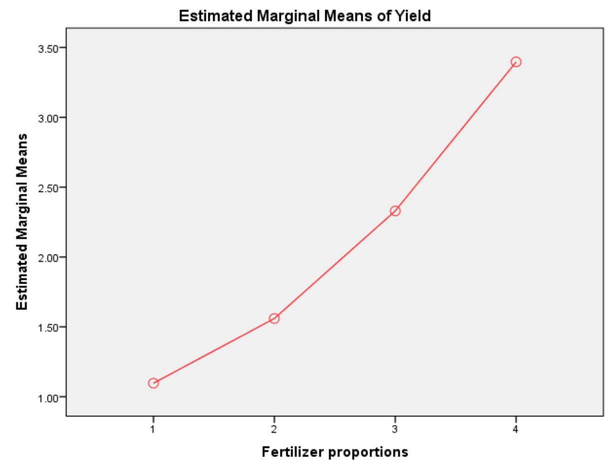

Figure 1

Table 6: Estimated Maize varieties Marginal Mean

Dependent Variable: Yield

Maize varieties	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	1.480	.310	.722	2.238
2	3.008	.310	2.249	3.766
3	1.800	.310	1.042	2.558

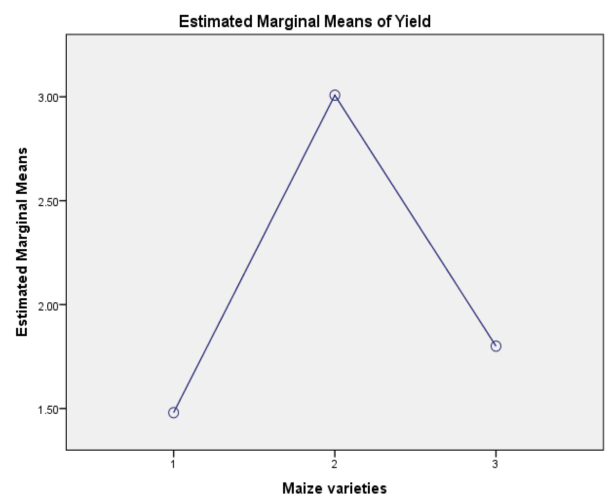

Figure 2

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 12
August 2016

Table 7: Tukey Multiple Comparisons Test for Fertilizer Proportions

Dependent Variable: Yield
Tukey HSD

(I) Fertilizer proportion	(J) Fertilizer proportion	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-.4633	.50598	.798	-2.2149	1.2882
	3	-1.2333	.50598	.169	-2.9849	.5182
	4	-2.3000*	.50598	.015	-4.0515	-.5485
2	1	.4633	.50598	.798	-1.2882	2.2149
	3	-.7700	.50598	.481	-2.5215	.9815
	4	-1.8367*	.50598	.041	-3.5882	-.0851
3	1	1.2333	.50598	.169	-.5182	2.9849
	2	.7700	.50598	.481	-.9815	2.5215
	4	-1.0667	.50598	.251	-2.8182	.6849
4	1	2.3000*	.50598	.015	.5485	4.0515
	2	1.8367*	.50598	.041	.0851	3.5882
	3	1.0667	.50598	.251	-.6849	2.8182

Based on observed means.
The error term is Mean Square(Error) = .384.
*. The mean difference is significant at the .05 level.

Table 8: Tukey Multiple Comparisons Test For Maize Varieties

Dependent Variable: Yield
Tukey HSD

(I) Maize varieties	(J) Maize varieties	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-1.5275*	.43819	.030	-2.8720	-.1830
	3	-.3200	.43819	.756	-1.6645	1.0245
2	1	1.5275*	.43819	.030	.1830	2.8720
	3	1.2075	.43819	.074	-.1370	2.5520
3	1	.3200	.43819	.756	-1.0245	1.6645
	2	-1.2075	.43819	.074	-2.5520	.1370

Based on observed means.
The error term is Mean Square(Error) = .384.
*. The mean difference is significant at the .05 level.

DISCUSSION OF RESULTS

From the ANOVA table (table 3), the *Sig.* value of 0.017 [< α(0.05)] for fertilizer proportions implies that the null hypothesis of no significant difference in the effect of fertilizer's proportions on the mean yield of maize is rejected. Similarly, the *Sig.* value of 0.029 for maize varieties implies that the null hypothesis of no significant difference in the effect of maize varieties on the mean yield of maize is rejected.

CONCLUSIONS

On the basis of the scope, methodology and analysis of the data, it can be concluded that at 5% significant level:

1. There is significant difference in the effect of the fertilizer's proportions on the yield of maize in Ogun State, Nigeria. In other words, fertilizer proportions do not give equal maize yield.
2. There is significant difference in the effect of the maize varieties on the yield of maize in Ogun State, Nigeria. In other words, maize varieties do not give the same maze yield.

3. The multiple comparisons test for fertilizer proportion indicates the significant difference to be between 50kg & 200kg fertilizers and between 100kg & 200kg fertilizers. However, an evaluation of the marginal mean revealed the 200kg fertilizer to be the most suitable.
4. The multiple comparisons test for maize varieties indicates the significant difference to be between Open pollinated and Hybrid maize. However, an evaluation of the marginal mean revealed the Hybrid type of maize to be the most suitable.

RECOMMENDATIONS

In the light of the findings of this study, the following recommendations are made for adequate maize yield in Ogun State, Nigeria.

1. The 200kg fertilizer proportion should be used.
2. The Hybrid type of maize should equally be used.

REFERENCES

[1] Agbato, S. O. (2003). Principles and Practices of crop production. Odumatt press publisher, Oyo, pp. 57-62.

[2] Cochran and Cox, John Wiley & Sons, Inc. (1957). Randomized Complete Block Designs, Adapted from Experimental Designs, 2nd ed.

[3] DIPA (2006). Handbook of Agriculture: facts and figures for farmers, students and all interested in farming. Directorate of Information and Publications of Agriculture. Indian Council of Agricultural Research, New Delhi, p. 435.

[4] Dutt, S. (2005). A Handbook of Agriculture. ABD Publishers, India. Pp 116-118.

[5] FAO (2002). Fertilizer and the future. IFA/FAO Agriculture Conference on Global food security and the role of Sustainability Fertilization. Rome, Italy. 16th-20th March, 2003, pp 1-2.

[6] Fayenisin, O. (1993). Search for Improved maize varieties for farmers in Nigeria. 3rd National Workshop of Maize Centre. NASPP, Ibadan December, 6th - 10th 1976.

[7] Iken, J. E., Anusa, A. and Obaloju, V. O. (2001). Nutrient Composition and Weight Evaluation of some Newly Developed maize Varieties in Nigeria. Journal of Food Technology, 7: 25-28.

[8] Kim, S. K. (1997). Achievement, challenges and future direction of hybrid maize research and product in B. Badu-Apraku, Akoroda M.O., Oedraw M. and Quin F.M(eds). Proceedings of Required Maize Workshop May 99-june 2, 1995. IITA Cotonou, Benin Republic.

[9] Odeleye, F. O. and Odeleye, M. O. (2001). Evaluation of morphological and agronomic characteristics of two exolic and two adapted varieties of tomato (Lycopersicom esculentum) in South West Nigeria. Proceedings of the 19th Annual Conference of HORTSON. (1): 140-145.

[10] Tolera, A., Berg, T. and Sundstol, F. (1999). The effect of variety on maize grain and crop residue yield and nutritive value of the Stover. Journal of Animal feed Science and Technology 79(3): 165-177.

[11] Zeidan, M. S., Amany, A. and Balor El-Kramany, M. F. (2006). Effect of N-Fertilizer and plant Density on Yield and Quality of maize in Sandy Soil. Research Journal of Agriculture and Biological Sciences, 2(4): 156-161.