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Research Paper

Comparative Study of the Growth and Yield of Okra (Abelmoschus esculentus L). CropsTreated with Poultry Droppings and N. P. K (20:10:10) Fertilizers

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Abstract
The experimental trial was carried out at the college demonstration farm site of the department of Agricultural Education of Federal College of Education, Kontagora, Niger State to assess the effects of poultry droppings and N.P.K 20:10:10 fertilizers on the growth and yield of Okra during the cropping season of 2022.The experimental trial was laid out as a Randomised Complete Block Design (RCBD) experiment with three treatments which were replicated six times each while giving rise to eighteen replications. The data collected on growth and yield parameters were analyzed by using One-way Analysis of Variance(ANOVA) and critical difference (CD) a modified t-test statistics for testing research hypotheses for test of significance.The calculated values of hypotheses 1, 2,3 and 4 were 55.49, 362.8, 31.65 and 100 respectively which were greater than their critical value (2.52) while their corresponding CD values were 19.75, 1.33, 1,58 and 1.6 respectively. The differences among the means of all treatments were greater than their corresponding CD values. Hence, all the null hypotheses were rejected at 5% level of significance and concluded with 95% confidence that the okra crops treated with poultry droppings had the highest height, number of leaves, number of branches and fresh yield as it is shown in the results of the findings of hypotheses 1, 2, 3 and 4 respectively. Based on these findings, it was recommended that okra farmers should use poultry droppings for the production of okra crops in sandy-loam soil during the raining season and that government should organized workshops through Agricultural Development Project (ADP) to enlighten farmers on the importance of poultry droppings for the cultivation of okra.

Keywords: Okra, Poultry Droppings, N P K 20:10:10 Fertilizer, Growth and Yield, RCBD, ANOVA,

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I. Introduction

Okra (*Abelmoschus esculentus L*) is an important vegetable crop that is widely cultivated in both tropical and subtropical regions of the world for its soft immature pods that are used for thickening soups and generation of income. (*Musa M et al; 2020*). The vegetable is rich with high density of nutrients and antioxidants that help in reducing the risks of serious health conditions. Specifically, it contains significant amount of lectin which is capable of inhibiting the growth of cancer cells in humans as well as polyphenols as an antioxidant which assist in reducing the risks of heart problems and stroke by preventing blood clothing and reducing free radical damage (Web MD. Editorial Contributors, 2022).

In another development, Babatola (2006), asserted that despite the nutritional and economic importance of okra, its yields in tropical countries such as Nigeria is not encouraging or partly low because of continuous decline in soil fertility. This view was substantiated by Anyaegbu *et al (*2012)that the growth and yield of okra crops in Nigeria are limited due to low fertility nature of most soils in many parts of Nigeria which is attributed to continuous cropping and short follows thereby affecting the economic landscape of the farmers negatively.

The issue of low fertility class of most soils in Nigeria has been of great concern to okra farmers for many years. AS a result of this, Shagufta R.(2012), opined that the application of poultry droppings to Okra crops have been found to be an effective cheap source of nutrients for sustainable production of Okra. This opinion was further expressed by Musa M. *et al; (2020)* that poultry droppings contains significant amount of the macro and micro nutrients as well as organic matter that is capable of improving the soil aeration capacity, microbial activities, texture, structure and porosity levels that are very cruicial for growth and yields of okra crops. The researcher also reported that the okra crops treated with poultry droppings had the highest height and numbers of leaves. In a similar way, Ufere N *et al* (2013) reported that okra crops treated with poultry droppings had the highest leaf area index and fresh weight. One of the most important characteristics of poultry manure is that it contains high density of nutrients responsible for the formation of chlorophyll molecule while giving the leaf its deep green colour (Odedokun*et al,*2020). *Ano et al (2005)* remarked that vegetables cultivated using organic manures such as poultry droppings are gaining popularity because of less chemical residue and better taste of fruits.

With respect to the provision of essential nutrients for crops growth and yield Hossain M. *et al* (2017) stressed that the application of inorganic fertilizers such as NPK 20:10:10 is an excellent alternative for enhancing soil fertility class thereby being capable of producing okra crops with maximum height,number of leaves,fresh weight as well as decreased insect pest infestation in okro farms. Ahmed *et al* (2012) stated that Nigerian farmers have been growing fruit and leaf vegetables with inorganic fertilizers such as NPK and urea. This is so because, they are easy to use, quickly absorbed and utilized by crops. In a similar way, Hossain *et al* (2017) opined that inorganic fertilizers are labeled and graded such as NPK 20:10:10 and as such, it is easier to determine the type and the amount of nutrients that one can apply. The researcher further expressed that the issue of nutrient imbalances and wastages can be reduced.

NPK fertilizer contains significant amount of nitrogen which is needed most by plants. This important nutrient is subject to greater losses from the soil-plant system even under the best management practices. In fact, 30 – 50% of applied nitrogen is lost through leaching dentrificaiton, nitrification and volatilization thereby making the availability of adequate nutrients to crops during their critical stages of growth and yield difficult. (Tilahun T *et al* 2013). This view was further expressed by Shagufta R. (2012) that unavailability of adequate nutrients to crops during their critical stages such as flowering and fruiting is one of the reasons for poor yield and nutritive value of crops most especially vegetables. The art of applying inorganic fertilizers such as NPK 20:10:10 for improving the growth and yield of okra crops has been constrained by acidity scarcity, nutrient imbalances, high cost, reduction and delay in setting of fruits when applied in excess. It is also dangerous to the environment and human health. (Tilahun*T. Alemayehu A and Minale L*,2013).

With this, there is an urgent need of the alternative sources of fertilizer for the production of okra crops. However, there is no adequate information concerning the effects of poultry droppings and NPK 20:10:10 fertilizers on the growth and yield of okra crops in the study area.Based on this credence, the experimental trial aimed at demonstrating the effects of poultry droppings and NPK 20:10:10 fertilizers on the growth and yield of okra crops in order to determine the best alternative between them for the production of okra crops.

1.1 Statement of the Problem

The problems of poor growth and yields of Okra crops have been attributed to depleted nature of most soils in Nigeria in which the study area is not an exemption. This phenomenon has been of great concern to okra farmers,researchers and policy makers for many years. This is one of the reasons why the okra fruits available in our markets today did not satisfy the demand of the people in terms of food and raw materials for our agro-based industries.

Also, the negative effects of the application of inorganic fertilizers such as NPK 20:10:10 to man and our environment as well as the mobile nature of nitrogen which is tagged as a chief nutrient for crop's growth and optimum yield has been of great concern to our researchers today. (Tilahun T, Alemayehu and Minale L 2013).

In Kontagora Local Government Area of Niger State in Nigeria, there is no adequate information concerning the effects of the poultry droppings and NPK 20:10:10 fertilizers on the growth and yields of okra crops. It is in the light of this, that the experimental trial was carried out in order to determine the best fertilizer for the production of okra crops in order to solve the problem that has been of great concern to okra farmers in

the study area and proffer appropriate policy recommendations that will benefits okra farmers and the would -be okra farmers in this regard.

1.2 Research Objectives

1. To determine the height of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.
2. To estimate the number of leaves of okra crops treated with poultry and NPK 20:10:10 fertilizers.
3. To evaluate the number of branches of okra crops produced by treating with poultry droppings and NPK 20:10:10 fertilizers.
4. To estimate the fresh weight of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers in the study area.

1.3 Research Hypotheses

1. There is no significant difference between the height of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.
2. There is no significant difference between the number of leaves of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.
3. There is no significant difference between the number of branches of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.
4. There is no significant difference between the fresh yield of okra crops produced by treating with poultry droppings and NPK 20:10:10 fertilizers.

II. Materials and Methods

2.1 Experimental Site

The Experimental trial was carried out at the demonstration farm site of Agricultural Education Department of Federal College of Education, Kontagora, Niger State. Kontagora Local Government Area lies in the Northern Guinea Savanna vegetation zone between Latitude 10^0 24.133N and Longitude 005^0 28.263E. The site is rich with well-drained sandy loam soil with an average annual sunshine of eight hours. (*Ibrahim et al,2020*).

2.2 Land Preparation, Experimental Design, Treatments and Cultural Practices.

Well-drained Sandy-loam soil was selected for the experiment and the debris composed of plants and animals remains were packed by using rake,hoe and spade. The experimental land was tilled and harrowed mechanically.The experiment was laid out as a Randomized Complete Block Design (RCBD) with three treatments and six replications while giving rise to eighteen replications. The size of each plot was 4meters square ($4m^2$).Six plots were treated with 500kg of poultry droppings and they were tagged as treatment A, other six plots served as control and they were tagged as treatment B while the last six plots were treated with 20kg of NPK 20:10:10 fertilizer and they were also tagged as treatment C.

The long pod okra seeds were planted early July during the cropping season of 2021. Thinning operation was carried out at 2 weeks after sowing while the weeding operation was carried out at two weeks interval throughout the experimental trial. The fertilizer application was carried out at 2 weeks and at 6 weeks after sowing. The harvesting was done at interval (4-5) days when the tender fruits of okra were edible. The first harvest was done at 55 days after sowing.

2.3 Data Collection

The growth parameters (height,number of leaves and branches) were measured periodically at 2, 4, 6 and 8 weeks after sowing while the fresh yield was measured at harvest.For easy collection of data, six stands of okra plants were randomly sampled from each plot whichgave rise to 108 experimental plants. The height was measured by using graduated metre rule, measuring from the base to the growing tips of the plants and their average means were recorded. The number of leaves and branches were determined by counting by the researcher and their average means were recorded. Harvested okra fruits were measured by using measuring scale and their average means were recorded. Data collections were carried out replication by replication for easy organization and analysis.

2.4 Theoretical Framework

Blocking is one of the basic principles of field experimentation that is often used by field experimenters in order to make the experimental materials to be as homogeneous as possible before randomly allocating the experimental materials to different experimental units. Hence, Randomization and blocking increase Local control by reducing experimental error and increasing precision and accuracy of the experiment. The principle of grouping similar homogenous experimental materials into blocks which are randomly allocated to treatment

units form the bases of merits in Randomized Complete Block Design. Blocking increases sample size in the experiment and the higher or larger the sample size, the more accurate and efficient the result of analysis because the amount of information collected is larger and copious.

Randomized complete Block Design is not suitable for large number of treatments because maintaining homogeneity in larger number of block sizes is difficult. Despite this defect, Randomized complete Block Design is a design that is mostly used in agricultural field experiments.

2.5 The Model

The analysis of variance (ANOVA) model for RCBD is a linear relationship which is expressed as

$$Y_{ij} = u + t_i + r_i + e_{ij} - 1$$

Where,

$U = Intercept\ term\ or\ overall\ mean;$

$t_i = the\ ith\ treatment\ effect;$

$$r_j = the\ jth\ repilcation\ effect\ and$$

$$e_{ij} = the\ error\ term.$$

The total variance is thus divided into three sources of variation, namely between replications, between treatments and error term. The required sums of squares are calculated as follows:

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

Where,

$$CF = correction\ factor$$

$$GT = grand\ total$$

$$rt = product\ of\ number\ of\ replications\ and\ treatments$$

$$Total\ SS = \sum yj^2 - CF - - - - - - - - - - - - - - - - - 3$$

$$Treatment\ SS\ \frac{1}{r}\sum Ti^2 - CF - - - - - - - - - - - - - - - - 4$$

$$Replication\ SS = \frac{1}{t}\sum Ri^2 - CF - - - - - - - - - - - - - - - - 5$$

$$Errors\ SS\ =\ Total\ SS\ -\ Replication\ SS\ -\ Treatment\ SS - - - 6$$

The above model was used to complete the analysis of variance (ANOVA) table. If the estimated value is greater than the observed value, it implies that treatments differ significantly. Then, the result can be further validated by the computation of Critical Difference (CD) in order to make appropriate decision.In other words,null hypothesis will be rejected. But, if the estimated value is less than the observed value, it means that the treatments do not differ significantly, Hence, accept the null hypothesis.

2.6 The t-test Statistics

The critical difference (CD) analysis also called least significant difference (LSD) was used as a modified t-test statistics to determine the difference between means of treatments that will assist in making appropriate statistical decision concerning the stated null hypothesis.

$$CD = t\ \text{x} SE\ (d) - 7$$

Where,

$$CD = critical\ difference$$

t = tabular value of t for a specified level of significance and degrees of freedom.

$$SE\ (d) = Standard\ error\ of\ difference$$

But $SE(d) = \sqrt{\frac{2(EMS)}{r}} - 8$

Where,

$$EMS = Error\ means\ square$$

$$R\ =\ number\ of\ replications$$

III. Data Analysis

The data collected were analysed by using One -Way Analysis of Variance (ANOVA) and the critical difference (CD) or the least significant difference (LSD) which is a modified t-test statistics for testing hypotheses for test of significant was also applied.

Table 1. Mean height of okra crops in cm per replication.

	Replications							
Treatments	I	II	III	IV	V	VI	Total	Means
A	100	120	140	120	90	140	710	118.33
B	35	40	30	35	40	35	215	35.83
C	70	80	70	60	80	75	435	72.55
Total	205	240	240	215	210	250	1360	226.7

A = Poultry droppings
B = Control
C = NPK 20:10:10 fertilizer

Hypothesis I: There is no significant difference between the height of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.

Table 2: ANOVA Table for hypothesis 1

Source of variation	DF	SS	MS	F
Replication	5	594.44	118.88	
Treatment	2	20501.95	10250.97	55.49
Error	10	1847.19	184.719	
Total	17	22944		

CD = 19.75

The calculated value (55.49) was greater than the critical value (2.52) and the differences between the means of all treatments were greater than the CD value. Hence, the null hypothesis was rejected at 5% level of significance and 10 degrees of freedom and concluded with 95% confidence that okra crops treated with poultry droppings had the highest height.

Table 3. Mean number of leaves of okra crops per replication.

	Replications							
Treatments	I	II	III	IV	V	VI	Total	Means
A	22	21	20	23	24	24	134	22.33
B	8	8	6	8	10	8	48	8.00
C	15	15	14	16	15	14	89	14.83
Total	45	44	40	47	49	46	271	45.16

Hypothesis 2: There is no significant difference between the number of leaves of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.

Table 4: ANOVA Table for hypothesis 2

Source of variation	DF	SS	MS	F
Replication	5	15.6	3.12	
Treatment	2	616.77	308.38	362.8
Error	10	8.58	0.85	
Total	17	640.95		

CD = 1.33

The estimated value of f-statistics (362.8) was greater than the observed value of f-statistics (2.52) and the null hypothesis was rejected. The analysis of CD also revealed that all the treatments differ significantly. This is so because the differences existing among the means of all treatment were greater than the CD value.

Table 5. Mean number of branches of okra crops per replication.

	Replications							
Treatments	I	II	III	IV	V	VI	Total	Means
A	6	7	8	5	10	8	44	7.33
B	2	2	3	3	2	2	14	2.33
C	4	4	5	4	6	3	26	4.33
Total	12	13	16	12	18	13	84	13.99

Hypothesis 3: There is no significant difference between the number of branches of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.

Table 6: ANOVA Table for hypothesis 3

Source of variation	DF	SS	MS	F
Replication	5	9.99	1.99	
Treatment	2	75.98	37.99	31.65
Error	10	12.02	1.20	
Total	17	98		

CD = 1.58

The computed value (31.68) was greater than the critical value (2.52) at 5% level of significance at 10 error df and the null hypothesis was rejected. The analysis of CD also shows that all the treatments differ significantly because the differences existing among the means of all treatment were greater than the CD value. This implies that the crops treated with poultry droppings had the highest number of branches.

Table 7. Mean fresh yield of okra crops in kg/replication.

	Replications							
Treatments	I	II	III	IV	V	VI	Total	Means
A	10	12	11	12	13	10	68	11.3
B	2	3	3	2	2	3	15	2.5
C	5	6	5	4	5	6	31	5.1
Total	17	21	19	18	20	19	114	18.9

Hypothesis 4: There is no significant difference between the fresh yield of okra crops treated with poultry droppings and NPK 20:10:10 fertilizers.

Table 8: ANOVA Table for hypothesis 4

Source of variation	DF	SS	MS	F
Replication	5	3.32	0.66	
Treatment	2	246.32	123.16	100
Error	10	12.36	1.23	
Total	17	262		

CD = 1.6

The calculated value (100) was greater than the critical value (2.52) at 5% level of significanceand concluded with 95% confidence that treatments differ significantly and the null hypothesis was rejected. Also, the CD analysis revealed that okra crops treated with poultry droppings had the highest fresh yield because the differences among the means of all treatments were greater than the CD value.

IV. Discussion of Results

The calculated values of hypothesis 1, 2, 3 and 4 are 55.49, 352.8, 31.65 and 100 respectively which were greater than their critical value (2.52). specifically, hypothesis 1 and 2 revealed that okra crops treated with poultry droppings had the highest height and numbers of leaves respectively. These findings are in agreement with the findings of Musa *et al (*2020*)* that okra crops treated with poultry droppings had the highest height and number of leaves.

It is evident in analysis of hypothesis 3 and 4 that okra crops treated with poultry droppings had the highest number of branches and fresh yield. The result of the findings of hypothesis 4 is in line with the result of the findings of Ufere N *et al* (2013) that the okra crops treated with poultry droppings had the highest fresh yield.

To validate the authenticity of these results, Musa M. *et al* (2020) stressed that poultry droppings is rich with both macro and micro nutrients as well as organic matter that is capable of improving the soil fertility class, aeration capacity, microbial activities, texture, structure and porosity levels that are very crucial for growth and yields of okra crops. On the other hand, Tilahun T, Alemayehu A and Minale L, (2013) opined that nitrogen as the chief nutrient for crops growth and yield is subject to losses through various means such as volatilization, leaching, percolation, run-off, denitrification and nitrification thereby reducing the efficacy of NPK 20:10:10 fertilizer on experimental plants. In the light of the above premises, the reasons in support of these findings were captured.

V. Conclusion and Recommendations

5.1 Conclusion

Based on the result of the findings of this experimental trial, it was concluded that poultry droppings contains significant amount of macro nutrients, micro nutrients and organic matter content capable of producing okra crops with the highest height, number of leaves, number of branches and fresh yield when compared with okra crops treated with NPK 20:10:10 fertilizer when cultivated in sandy-loam soil in the raining season.

5.2 Recommendations:

i. Okra farmers should use poultry droppings when producing okra crops in sandy-loam soil in the raining season.

ii. Government should organized workshops through Agricultural Development Projects (ADP's) to enlighten farmers on the importance of poultry droppings for the cultivation of okra crops.

iii. Okra farmers should form co-operative societies to enable them acquire loans from financial institutions for sourcing poultry droppings and other inputs for organic farming which is friendly to the environment and man.

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