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Comparative Effect of Organic and Inorganic Manure on the Growth of Maize (*Zea mays*) in Makurdi, Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Maize is an important cereal crop that is not only rich in carbohydrate but also a potential source of protein and essential minerals. Comparative effect of organic and inorganic manure on the growth of maize (*Zea mays)* was investigated in this study using two varieties of maize namely: SAMMAZ 52 and TZEE 2009. Soil samples were collected from the bank of river Benue, Makurdi and were mixed with the various manure and taken to the Department of Agronomy, Federal University of Agriculture, Makurdi for analysis. A 2x4 factorial scheme fitted into a completely randomized design with three replicates was adopted for the study in which twenty four pots were filled with about 14 kg of soil of uniform properties. Six of the pots were mixed with 1.5 kg of poultry droppings, six with 1.5 kg NPK fertilizer s and six with 1.5 kg goat dung leaving six pots free of organic or inorganic fertilizers. The setup was left for two weeks before planting. The hybrid seeds were sown into each of the soil and Agronomic data were collected weekly up to a period of 10weeks. Investigation showed that poultry droppings had better results in terms of pH, organic matter, nitrogen, phosphorous and exchangeable cation. Organic fertilizers also produced significantly higher yields than the inorganic fertilizer especially with poultry droppings treated soils in all parameters including

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plant height, number of leaves and leaf area; SAMMAZ 52 having significantly higher yields than TZEE 2009. ??It was concluded that organic fertilizer improves the chemical and physiochemical properties of the soil thereby increasing the growth of maize; the use of poultry droppings as an organic manure having a more significant effect in enhancing growth than inorganic manure. It is recommended that organic fertilizers be adopted by farmers as a potent alternative to inorganic fertilizers in promoting growth in maize plant and other cereals.

Keywords: Maize; fertilizers; inorganic manure; organic manure; SAMMEZ 52; TZEE 2009; growth.

1. INTRODUCTION

Maize (*Zea mays* L.) is an annual cereal plant of the Poaceae family and native to Mexico [1]. Maize was introduced into Nigeria in the 16th century by the Portuguese [2] and based on the area cropped and quantity produced; maize was the country's first most important crop among other prominent cereals such as rice, wheat, sorghum and millet [3]. In developing countries, where many of the farmers are resource-poor, maize is a good source of income as the crop could be cultivated on the same piece of land two or more times in one year. It is an important cereal crop that is not only rich in carbohydrate but also a potential source of protein and essential minerals. Maize grains are a rich source of starch (72%), ash (17%), protein (10.4%), fiber (2.5%), oil (4.8%), vitamins and minerals [4]. Maize grain also contains mineral salts and essential trace element containing-compounds [5]. Improving soil fertility management among smallholder farmers is widely recognized as a critical approach to addressing enhanced crop yields and poverty alleviation, especially in sub-Sahara Africa, where the majority of the populations earn their livelihood as smallholder farmers [6]. Sustained soil fertility management is a requirement for enhanced crop productivity and income in agri-business. Organic and inorganic fertilizers are essential for plant growth. Both fertilizers supply plants with the nutrients needed for optimum performance. Organic fertilizers have been used for many centuries whereas chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution. Inorganic fertilizers has significantly supported global population growth, it has been estimated that almost half the people on the earth are currently fed as a result of artificial nitrogen fertilizer use [7]. Commercial and subsistence farming has been and is still relying on the use of inorganic fertilizers for growing crops [8]. This research was aimed at investigating the variability of the maize seeds, determine the effect of organic and inorganic manure on the growth of maize, determine the type of manure that is most effective in the growth of this crop and to determine the comparative effect of organic and inorganic manure on selected parameters used for the evaluation of plant growth of two selected varieties of maize *(Zea mays)*.

2. MATERIALS AND METHODS

This study was conducted at screen house, Department of Biological Sciences Garden, Benue State University, Makurdi. The city is located in central Nigeria along the Benue River, on latitude $07^0$43'N and Longitude $08^0$35'E. The mean annual rainfall in Makurdi is about 1,290mm. Temperature in Makurdi is however, generally high throughout the year, with February and March as the hottest months. Temperature in Makurdi varies from a daily of 40^0C and a maximum of 22.5^0C [9]. The study was conducted between December 2017 and February 2018.

2.1 Maize Sample Collection and Preparation

Prior to planting, hybrid maize seed variety SAMMAZ 52 and TZEE 2009 were obtained from University of Agriculture Teaching and Research Farm, Makurdi. These seeds have been validated through advanced scientific methodology to be free from pests and diseases that might hinder normal growth and development of the maize plants. Germination test was carried out to ascertain the potency of the seeds used for the study by adopting the methodology of Rawson and Macpherson [10]. This is to ensure that results obtained are not influenced by external factors such as impotency which might hinder the growth parameters to be recorded at the end of the experimental period.

2.2 Experimental Procedure and Design

The pots were arranged in a 2x4 factorial scheme fitted into a completely randomized

design giving eight (8) treatment combinations with three replicates. Twenty four pots were filled with about 14 kg of soil of uniform properties, six pots were mixed with poultry droppings at a rate of 1.5 kg per pot, six were mixed with NPK fertilizer at 1.5 kg per pot, and six were mixed with goat dung at rate of 1.5 kg per pot leaving six bags free from organic manure two weeks before planting.

2.3 Cultural Practices

- Method of planting was by direct seeding.
- Weeding operations were carried out hand weeding at three days intervals.
- Irrigation was by sprinkling of water on plants.

2.4 Agronomic Data Collection

Agronomic data were collected weekly up to a period of 10 weeks. Data collected included plant height, leaf area and number of leaves.

Plant height was collected using a meter rule, number of leaves was carried out by visual observation and counting while leaf area was calculated by multiplying the length of leaf by its breadth.

2.5 Data Analysis

The data obtained were analyzed Using Analysis of Variance by subjecting the results obtained to Statistical Package for Social Sciences (SPSS) version 21. Comparative analysis of the results was done using Fishers least significant difference significance and t-test was used for comparison of germination results at 5% level of significance. A p-value less than 0.05 ($p<0.05$) was considered statistically significant.

3. RESULTS AND DISCUSSION

3.1 Germination Percentage

Data presented in Table 1 showed that no germination occurred on the first and second day of planting. However, as from the third day of planting, germination increased steadily from day 3 to day 12. SAMMAZ 52 gave significantly higher germination percentage than TZEE 2009.

3.2 Plant Height at 1, 2, 3, 4 and 5 WAP

The main effect of fertilizer as well as the interaction effects of maize variety x fertilizer was significant on the plant height of maize at 1 WAP. At 2, 3 and 4 WAP, only the main effect of fertilizer was significant on the plant height of maize. The main effect of fertilizer as well as the interaction effects of maize variety x fertilizer was significant on the plant height of maize at 5 WAP. At 1 WAP, SAMMAZ 52 produced the highest plant height of maize when it was applied with poultry manure but this was not significantly different from that produced when SAMMAZ 52 was also applied with NPK fertilizer. The control produced the lowest plant height at 1 WAP regardless of the maize variety used (Table 2). SAMMAZ 52 gave higher plant height at 1 WAP than TZEE 2009 but the difference was not significant. Poultry manure generally gave higher plant height at 1 WAP than all the other fertilizers but this was not significantly different from that produced by NPK fertilizer (Table 1).

At 2, 3 and 4 WAP, SAMMAZ 52 applied with poultry manure gave the highest plant height but the difference was not significant (Table 2).On a general note, SAMMAZ 52 gave significantly higher plant height than TZEE 2009 at 2, 3 and 4 WAP but no significant difference was observed. Poultry manure gave higher plant height of maize at 2, 3 and 4 WAP than NPK, goat dung and the control respectively (Table 2). At 5 WAP, SAMMAZ 52 treated with poultry manure produced the highest plant height and the difference was significantly higher than that produced by any other interaction. SAMMAZ 52 produced the lowest plant height at 5 WAP when no fertilizer was applied to it (Table 3).

SAMMAZ 52 produced higher plant height than TZEE 2009 at 5 WAP but the difference was not significant. Generally, poultry manure gave significantly higher plant height at 5 WAP than all the other fertilizers (Table 2).

3.3 Plant Height at 6, 7, 8, 9 and 10 WAP

The main effect of fertilizer was significant on the plant height of maize at 6, 7, 8, 9 and 10 WAP but the main effect of maize variety as well as the interaction effects of maize variety x fertilizer was not. At 6 WAP, SAMMAZ 52 gave the highest plant height of maize among the interactions when it was applied with poultry manure but the difference was not significant. A similar trend was observed at 7, 8, 9 and 10 WAP where SAMMAZ 52 also gave the plant height of maize was supplied with poultry manure but the difference was also not significant (Table 4). SAMMAZ 52 generally gave higher plant height of maize than

Table 1. T-Test showing germination percentage of two maize varieties in Makurdi

Variety	Germination Percentage (%)											
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12
SAMMAZ 52	0.00±000	0.00±0.00	23.00±12.65	39.00±15.45	57.00±18.87	58.00±20.75	55.00±11.78	59.00±12.11	63.00±11.31	59.00±13.65	67.00±11.45	89.00±11.87
TZEE 2009	0.00±0.00	0.00±0.00	16.00±10.00	29.00±8.64	44.00±11.49	48.00±12.65	58.00±6.00	53.00±9.36	61.00±11.93	63.00±10.00	63.00±9.64	74.00±8.39
Unpaired t-test (0.05)	0.00^{ns}	0.00^{ns}	0.63*	1.14*	0.81*	0.59*	0.77*	0.91*	1.21*	0.99*	1.55*	1.03*

** = significant; ns = not significant*

Table 2. Main effect of variety and fertilizer on the plant height of maize at 1, 2, 3, 4 and 5 WAP in Makurdi

	Plant Height (cm)				
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
Variety					
SAMMAZ 52	11.74	25.16	37.08	62.12	72.21
TZEE 2009	9.59	22.95	36.65	61.23	69.80
LSD (0.05)	NS	NS	NS	NS	NS
Treatment					
Control	4.13	6.21	16.82	35.09	49.32
NPK	14.35	33.78	44.22	70.64	70.67
Goat Dung	7.89	22.07	37.94	57.38	63.59
Poultry	16.29	34.17	49.34	83.59	100.44
LSD (0.05)	3.12	5.47	6.29	13.74	13.08

WAP: weeks after planting; NS: not significant

Table 3. Interaction effects of variety x fertilizer on the plant height of maize at 1, 2, 3, 4 and 5 WAP in Makurdi

Variety	Fertilizer	Plant Height (cm)				
		1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
SAMMAZ 52	Control	5.20	5.04	13.92	25.13	37.75
	NPK	15.91	37.17	45.58	77.06	74.11
	Goat Dung	6.69	20.48	39.51	57.31	61.54
	Poultry	19.14	37.95	51.03	88.99	115.44
TZEE 2009	Control	3.06	7.38	19.72	45.06	60.89
	NPK	12.79	29.60	42.36	64.22	67.22
	Goat Dung	9.09	23.65	36.37	57.44	65.64
	Poultry	13.43	31.17	47.64	78.18	85.44
LSD (0.05)		4.42	NS	NS	NS	18.50

WAP: weeks after planting; NS: not significant

Table 4. Main effect of variety and fertilizer on the plant height of maize at 6, 7, 8, 9 and 10 WAP in Makurdi

	Plant Height (cm)				
	6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
Variety					
SAMMAZ 52	87.17	97.18	108.85	110.47	115.47
TZEE 2009	84.76	93.66	100.65	103.25	107.93
LSD (0.05)	NS	NS	NS	NS	NS
Treatment					
Control	64.06	70.92	81.00	82.03	86.39
NPK	78.11	81.44	91.11	94.00	100.84
Goat Dung	67.34	79.76	87.83	88.11	90.00
Poultry	134.35	149.56	159.07	163.32	169.56
LSD (0.05)	17.27	20.88	21.96	21.86	22.34

WAP: weeks after planting; NS: not significant

TZEE 2009 at 6, 7, 8, 9 and 10 WAP but the difference was not significant. Poultry manure consistently gave significantly higher than height among the fertilizers evaluated at 6, 7, 8, 9 and 10 WAP (Tables 4 & 5).

3.4 Leaf Area at 1, 2, 3, 4 and 5 WAP

The main effect of maize variety and fertilizer as well as the interaction effects of maize variety x fertilizer on the leaf area of maize was significant at 1 WAP. At 2 and WAP, the main effect of maize variety x fertilizer was significant on leaf area but the interaction effects of maize variety x fertilizer was not. At 4 and 5 WAP, the main effect of fertilizer was significant on the leaf area of maize but the main effect of maize variety as well as the interaction effects of maize variety x fertilizer was not. At 1 WAP, SAMMAZ 52 produced the highest leaf area when it was applied with poultry manure and the difference was significant. The lowest leaf area of maize at 1 WAP was produced with TZEE 2009 control (Table 7). SAMMAZ 52 produced significantly higher leaf area than TZEE 2009 at 1 WAP. Among the fertilizers evaluated, poultry manure produced the highest leaf area at 1 WAP but the difference was not significantly higher than that produced by NPK fertilizer (Table 6). At 2 WAP, SAMMAZ 52 applied with poultry manure and TZEE 2009 applied with no fertilizer gave the highest leaf and lowest leaf area but the difference was not significant (Table 7). SAMMAZ 52 gave higher leaf area at 2 WAP than TZEE 2009 and the difference was significant. Poultry manure generally gave significantly higher leaf area than NPK, goat dung and the control (Table 7). At 3 WAP, SAMMAZ 52 also gave the highest leaf area of maize when treated with poultry manure but the difference was not significant (Table 7).

Table 5. Interaction effects of Variety x Fertilizer on the Plant Height of Maize at 6, 7, 8, 9 and 10 WAP in Makurdi

Variety	Fertilizer	Plant Height (cm)				
		6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
SAMMAZ 52	Control	54.33	67.39	79.69	80.48	84.20
	NPK	84.22	86.78	94.08	99.05	107.10
	Goat Dung	63.80	72.75	91.39	91.52	93.06
	Poultry	146.34	161.81	170.24	170.23	177.53
TZEE 2009	Control	70.89	74.44	82.31	83.58	86.94
	NPK	73.78	86.78	88.13	88.34	94.59
	Goat Dung	72.00	76.11	84.28	84.69	88.59
	Poultry	122.37	137.30	147.89	156.41	161.59
LSD (0.05)		NS	NS	NS	NS	NS

WAP: weeks after planting; NS: not significant

Table 6. Main effect of variety and fertilizer on the leaf area of maize at 1, 2, 3, 4 and 5 WAP in Makurdi

	Leaf Area (cm^2)				
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
Variety					
SAMMAZ 52	13.01	42.98	85.90	172.03	226.04
TZEE 2009	8.32	26.89	58.28	141.09	195.49
LSD (0.05)	2.48	9.47	20.48	NS	NS
Fertilizer					
Control	3.02	4.19	10.30	56.22	108.73
NPK	15.03	45.99	94.06	172.23	190.37
Goat Dung	7.03	36.42	79.15	106.40	115.92
Poultry	17.59	53.13	104.84	291.39	428.03
LSD (0.05)	3.51	13.39	28.96	72.68	73.51

WAP: weeks after planting; NS: not significant

SAMMAZ 52 gave significantly higher leaf area at 3 WAP than TZEE 2009. On a general note, poultry manure gave the highest leaf area at 3 WAP, and the difference was significantly higher than that produced by any other fertilizer (Table 6). A similar trend was observed at 4 and 5 WAP where SAMMAZ 52 applied with poultry manure gave the highest leaf area among the interactions though no significant difference was observed (Table 7). SAMMAZ 52 gave higher leaf area at 4 and 5 WAP than TZEE 2009 but the difference was not significant. Generally, poultry manure gave significantly higher leaf area than all the other fertilizers at 4 and 5 WAP (Table 7).

3.5 Leaf Area at 6, 7, 8, 9 and 10 WAP

The main effect of maize variety and fertilizer as well as the interaction effects of maize variety x fertilizer on the leaf area of maize at 6 WAP was significant but only the main effect of maize variety and fertilizer was significant on the leaf area of maize at 7, 8, 9 and 10 WAP. Data presented in Table 8 showed that SAMMAZ 52gave the highest plant height at 6 WAP when it was applied with poultry manure and this was significantly higher than that produced by any other treatment. SAMMAZ 52 gave the lowest leaf area at 6 WAP when it was not applied with fertilizer. Generally, SAMMAZ 52 gave significantly higher leaf area than TZEE 2009 at 6 WAP. Poultry manure gave significantly higher leaf area than all the other fertilizers (Table 8). At 7, 8, 9 and 10 WAP, SAMMAZ 52 produced the highest leaf area when it was applied with poultry manure but the difference was not significant (Table 9). Generally, SAMMAZ 52 gave significantly higher leaf area than TZEE 2009 at 7, 8, 9 and 10 WAP. Poultry manure and the control gave the highest and the lowest leaf area of maize at 7, 8, 9 and 10 WAP respectively (Table 8).

Table 7. Interaction effects of variety x fertilizer on the leaf area of maize at 1, 2, 3, 4 and 5 WAP in Makurdi

Variety	Fertilizer	Leaf Area (cm^2)				
		1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
SAMMAZ 52	Control	5.36	4.87	4.48	31.27	69.19
	NPK	18.28	59.17	117.99	219.61	246.58
	Goat Dung	5.96	41.12	91.98	115.54	122.80
	Poultry	22.46	66.76	129.15	321.72	465.61
TZEE 2009	Control	2.69	3.52	16.12	81.18	148.28
	NPK	11.77	32.82	80.54	124.84	134.17
	Goat Dung	8.10	31.72	66.32	97.26	109.05
	Poultry	12.73	39.50	70.12	261.07	390.45
LSD (0.05)		4.96	NS	NS	NS	NS

WAP: weeks after planting; NS: not significant

Table 8. Main effect of Variety and Fertilizer on the Leaf Area of Maize at 6, 7, 8, 9 and 10 WAP in Makurdi

	Leaf Area (cm^2)				
	6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
Variety					
SAMMAZ 52	283.01	334.15	355.86	359.38	366.56
TZEE 2009	218.80	257.02	263.11	273.58	281.34
LSD (0.05)	50.91	74.39	73.47	73.71	72.78
Treatment					
Control	119.41	126.73	137.47	148.43	164.03
NPK	185.48	206.07	216.20	219.39	221.14
Goat Dung	203.71	256.03	258.09	267.75	273.97
Poultry	495.02	593.51	626.19	630.36	636.66
LSD (0.05)	72.10	105.21	103.91	104.24	102.92

WAP: weeks after planting; NS: not significant

3.6 Number of Leaves at 1, 2, 3, 4 and 5 WAP

The main effect of fertilizer was significant on the number of leaves of maize at 1 WAP, but the main effect of maize variety as well as the interaction effects of maize variety x fertilizer was not significant. At 2, 3 and 4 WAP, the main effect of fertilizer was well as the interaction effects of maize variety x fertilizer was significant on the number of leaves of maize but the main effect of maize variety was not. At 5 WAP, the main effect of maize variety and fertilizer was significant on the number of leaves of maize but the interaction effects of maize variety x fertilizer was not. At 1 WAP, TZEE 2009 gave the highest number of leaves when applied with NPK fertilizer but the difference was not significantly higher than that produced by other interactions. A dissimilar trend was observed at 2 WAP where SAMMAZ 52 produced the highest number of leaves when treated with NPK fertilizer but the difference was not significantly different from that produced when SAMMAZ 52 was applied with goat dung and when TZEE 2009 was applied with goat dung (Table 11). At 3 WAP, TZEE 2009 gave the highest number of leaves when applied with NPK fertilizer but the difference was not significantly higher than that produced when TZEE 2009 was applied with NPK fertilizer and when SAMMAZ 52 was applied with poultry manure. Irrespective of the variety evaluated, poultry manure gave the highest number of leaves at 4 WAP. TZEE 2009 applied with poultry manure gave the highest number of leaves at 5 WAP but there was no significant difference from that produced by other interactions (Table 9).

Generally, SAMMAZ 52 gave higher number of leaves than TZEE 2009 at 1, 2, 3, 4 and 5 WAP but significant difference was only observed at 5 WAP. Among the fertilizers evaluated, NPK fertilizer gave the highest number of leaves at 1 WAP but this was not significantly different from that produced by goat dung. Goat dung produced the highest number of leaves at 2 WAP

Table 9. Interaction effects of variety and fertilizer on the leaf area of maize at 6, 7, 8, 9 and 10 WAP in Makurdi

Variety	Fertilizer	Leaf Area (cm^2)				
		6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
SAMMAZ 52	Control	118.01	273.33	284.88	290.82	293.97
	NPK	235.73	268.27	284.50	288.54	290.00
	Goat Dung	177.17	124.21	140.32	145.11	160.92
	Poultry	601.13	670.79	713.73	713.05	721.33
TZEE 2009	Control	120.81	238.73	231.29	244.69	253.97
	NPK	135.22	143.88	147.90	150.23	152.28
	Goat Dung	230.26	129.24	134.62	151.74	167.14
	Poultry	388.91	516.22	538.64	547.67	551.99
LSD (0.05)		101.82	NS	NS	NS	NS

WAP: weeks after planting; NS: not significant

Table 10. Number of leaves of maize at 1, 2, 3, 4 and 5 WAP as influenced by the main effect of maize variety and fertilizer in Makurdi

	Number of Leaves				
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
Variety					
SAMMAZ 52	2.19	3.77	4.78	6.50	6.79
TZEE 2009	2.27	3.64	4.70	6.10	6.47
LSD (0.05)	NS	NS	NS	NS	0.89
Treatment					
Control	1.04	2.17	3.28	5.53	5.72
NPK	2.94	4.42	5.31	5.53	5.97
Goat Dung	2.84	4.47	5.00	6.17	6.07
Poultry	2.11	3.77	5.39	7.99	8.74
LSD (0.05)	0.24	0.26	0.18	0.67	1.25

WAP: weeks after planting; NS: not significant

but this was not significantly different from hat produced by NPK fertilizer. Poultry manure gave the highest number of leaves at 3, 4 and 5 WAP (Table 10).

3.7 Number of Leaves at 6, 7, 8, 9 and 10 WAP

The main effect of fertilizer as well as the interaction effects of maize variety x fertilizer was significant on the number of leaves at 6, 7 and 8 WAP but the main effect of maize variety was not. The main effect of fertilizer as well as the interaction effects of maize variety x fertilizer was significant on the number of leaves at 9 WAP but the main effect of maize variety was not. The main effect of maize variety and fertilizer as well as the interaction effects of maize variety x fertilizer was significant on the number of leaves at 10 WAP. At 6, 7 and 8 WAP, SAMMAZ 52 produced the highest number of leaves when applied with poultry manure but the difference was not significant (Table 13). Similarly, SAMMAZ 52 produced the highest number of leaves at 9 and 10 WAP when it was applied with poultry manure. TZEE 2009 gave the lowest number of leaves at 9 and 10 WAP when no fertilizer was applied (Table 13). Generally, no significant difference was observed between the maize varieties except at 10 WAP where SAMMAZ 52 gave significantly higher number of leaves than TZEE 2009. Among the fertilizers evaluated, poultry manure gave the highest number of leaves at 6, 7, 8, 9 and 10 WAP and the difference was significant (Table 12).

3.8 Discussion

Fertilizer application has become a necessary part of every cropping system due to the need for replenishment of nutrients which are mostly unavailable to plants in the required amounts. This formed the basis for this research which is aimed at investigating the comparative effects of organic and inorganic manure on the yield of maize (*Zea mays*). The comparison which

Table 11. Number of leaves of maize at 1, 2, 3, 4 and 5 WAP as influenced by the interaction effects of maize variety x fertilizer in Makurdi

Variety	Fertilizer	Number of Leaves				
		1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
SAMMAZ 52	Control	1.00	2.33	3.00	5.17	5.67
	NPK	2.89	4.72	5.61	6.28	6.50
	Goat Dung	2.89	4.55	5.00	6.33	6.53
	Poultry Manure	2.00	3.46	5.53	8.24	8.45
TZEE 2009	Control	1.07	2.00	3.56	5.89	5.78
	NPK	3.00	4.11	5.00	4.78	5.44
	Goat Dung	2.78	4.39	5.00	6.00	5.61
	Poultry	2.22	4.07	5.26	7.75	9.03
LSD (0.05)		NS	0.36	0.26	0.94	NS

WAP: weeks after planting; NS: not significant

Table 12. Number of leaves of maize at 6, 7, 8, 9 and 10 WAP as influenced by the main effect of maize variety and fertilizer in Makurdi

	Number of Leaves				
	6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
Variety					
SAMMAZ 52	7.34	8.53	9.46	7.14	6.58
TZEE 2009	6.95	8.89	9.10	6.65	5.95
LSD (0.05)	NS	NS	NS	NS	0.59
Treatment					
Control	6.08	8.53	8.25	6.64	6.58
NPK	6.67	7.72	9.11	6.42	5.25
Goat Dung	5.76	7.48	8.05	6.17	5.11
Poultry	10.07	11.10	11.70	8.35	8.10
LSD (0.05)	1.32	1.33	1.53	1.08	0.83

WAP: weeks after planting; NS: not significant

Table 13. Number of leaves of maize at 6, 7, 8, 9 and 10 WAP as influenced by the interaction effects of maize variety x fertilizer in Makurdi

Variety	Fertilizer	Number of Leaves				
		6 WAP	7 WAP	8 WAP	9 WAP	10 WAP
SAMMAZ 52	Control	6.17	7.83	9.17	7.83	8.17
	NPK	7.22	7.33	8.67	6.17	4.67
	Goat Dung	5.52	7.13	7.54	5.67	5.21
	Poultry	10.46	11.83	12.46	8.87	8.26
TZEE 2009	Control	6.00	9.22	7.33	5.44	5.00
	NPK	6.11	8.11	9.56	6.67	5.83
	Goat Dung	6.00	7.83	8.56	6.67	5.00
	Poultry	9.68	10.38	10.95	7.83	7.95
LSD (0.05)		NS	NS	NS	1.53	1.18

WAP: weeks after planting; NS: not significant

involved the measurement of growth of two species of maize namely SAMMAZ 52 and TZEE 2009 based on selected parameters showed a marked difference in growth from 1 week after

planting (WAP) till the end of the experimental period. The selected growth parameters which included plant height, leaf area and number of leaves differed greatly during the experimental period within varieties and within organic and inorganic manure. Plant height of maize was highest for SAMMAZ 52 applied with poultry manure at the start of the experiment but was not statistically different from that produced by SAMMAZ applied with NPK fertilizer. The height was however comparatively lower than that recorded by the control plant at the same period (1WAP). The high plant height recorded by the SAMMAZ 52 applied with poultry plant can be attributed in part to the soil properties of the Poultry treated soil sample which had a relatively higher value for pH which was almost near neutral as well as exchangeable cations which had higher values than the other treated samples. Comparison of the Exchangeable acidity and total exchangeable base of the soil samples also presented higher values for the soil sample treated with poultry. Plant variety SAMMAZ 52 produced higher plant height than TZEE 2009 at 5 WAP but the difference was not significant. The effect of poultry treated soil sample however became statistically significant with respect to height from 5 WAP declining in the other weeks prior to the end of the experiment when fruiting was setting in. this observation could be as a result of the normal growth cycle which rises up, slopes and then falls when no possible growth is possible at the fruiting stages (when maize cobs are produced). Plants treated with poultry organic manure therefore produced taller plants than those treated with inorganic fertilizers. This observation is in agreement with Okoroafo et al. [11] who reported that maize plant treated with poultry gave the highest plant height across all weeks. The observation also agrees with the report of Olatunji et al. [12] who lay credence to the claim that Okra and tomatoes when grown in poultry manure performed better than their counterparts in other manure types. In terms of leaf area, the main effect of maize variety and fertilizer as well as interaction effects of maize variety on the area of maize was significant at 1 WAP. The main effect of fertilizer on maize was also significant while the interaction effects of maize variety and fertilizer was not significant on leaf area. Highest leaf area was recorded for SAMMAZ 52 applied with poultry manure and the difference was significant while the lowest leaf area was produced when TZEE 2009 was not fertilized (control) (Table 8). A similar trend was observed at 4 and 5 WAP where SAMMAZ 52 gave higher leaf area among the interactions though no significant difference was observed. This implies that application of manure significantly increases the leaf area of plants treated with fertilizers when compared with those without it. However, poultry manure seemed to possess this domineering power when compared to other organic manure considered in this study. The ability of poultry which is an organic manure to increase leaf area significantly is in agreement with the findings of Edu et al. [13] who reported that organic fertilizer (poultry liter) affected some important morphological traits specifically leaf area of *T. occidentalis*. Unlike the other parameters discussed above where SAMMAZ 52 treated with poultry produced highest number of leaves than the other treatment combinations, TZEE 2009 gave the highest number of leaves with NPK at 1 WAP and also gave the highest number of leaves at 4WAP, 5WAP with poultry manure. In General therefore, poultry gave the highest number of leaves at 3, 4 and 5 WAP (Table 10) and no significant difference was observed between the maize varieties except at 10 WAP where SAMMAZ 52 gave significantly higher number of leaves than TZEE 2009. It can therefore be said that poultry manure gave the highest number of leaves throughout the entire study period and the difference was statistically significant (Table 12).

Ability of poultry manure which is an organic fertilizer to increase number of leaves significantly can be attributed its role in stimulating rapid leaf production and play an essential role in branching. Indeed, Hoque *et al.,* [14] reported that the application of compost manure to seedling of *Carica papaya* significantly increases the number of leaves and branches produced in agreement with the findings of this study. In general, Control plants in which fertilizers were absent in this study, presented the least amount of growth in virtually all parameters since enhancers of growth which mostly are ions, essential and non-essential nutrients were relatively low in them. Plants in which fertilizers were present however presented the highest values for all parameters when compared with inorganic fertilizers. Goat dung treated samples also had stunted growth and yellowing due to low nitrogen, phosphorus and potassium levels. This correlates greatly with the reports of Hector, [15] who said organic fertilizers especially poultry and inorganic fertilizer (mainly NPK) enriched Nitrogen, phosphorus, potassium, and organic matter of soils. Organic fertilizers also produced significantly higher yields than

inorganic fertilizers especially when poultry is used; a finding which is in agreement with Edu et al. [13] who reported that best growth in terms of height, number of leaves and branches are obtained for groups given chicken litter which comparatively performed better than groups treated with NPK fertilizers.

4. CONCLUSION

The study showed that the use of organic fertilizers improved the chemical and physicochemical properties of the soil thereby increasing the growth of maize. This growth was representatively visible in terms of increase in height, number of leaves and leaf area which were the growth parameters considered. The use of poultry as an organic manure had a more significant effect in enhancing growth of maize than any other type of manure or inorganic fertilizer used in the study and contained more minerals and nutrients required for plant growth. This is evident from results obtained from soil analysis conducted as part of this study.

5. RECOMMENDATION

From this study, it is recommended that:

- Organic fertilizers should be adopted by farmers as a potent alternative to promoting growth in maize plant and other cereals consumed as a major staple food by Nigerians and the world at large.
- Poultry droppings should be maximized by animal farmers and packaged in suitable containers for sale as compact organic fertilizers. This way, the value accrued to its usage would be highly enhanced.
- More research on the comparative effect of organic and inorganic fertilizers should be carried out by researchers on other foods especially cereals and legumes. This should be supported and funded by government and non-governmental organizations on a large scale so as to ensure success of the research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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