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# EFFECTS OF POULTRY MANURE AND NPK FERTILIZER APPLICATION ON GROWTH AND YIELD OF SORGHUM ( *Sorghum bicolor L Moench*) ON AN ULTISOL SOIL OF BAUCHI STATE, NIGERIA.

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***Abstract***

*A field experiment was conducted at the Teaching and Research Farm of the Abubakar Tafawa Balewa University, Bauchi, Nigeria. The research was carried out to study the effect of poultry manure and NPK fertilizer on the growth and yield of sorghum*

**KEYWORDS:** *Effect, poultry manure,NPK fertilizer, growth, yield, sorghum(Sorghum bicolr L Moench*

**INTRODUCTION**

Sorghum {*Sorghum bicolor (L.)Moench}* belongs to the family *poaceae,*sub-family *panicoideae* and tribe *andropogoneae*.It is the 5th most important cereal crop in the world after rice (*Oryza sativa L.*) wheat (*Triticum aestivum L.*), maize (*Zea mays L.*) and barley (*Hordeum vulgare L.*) (Musa *et al.*, 2011). It is used for food in Africa and many parts of Asia, cattle feed, bio-energy, thatch making, roofing of houses,brewing beer and for the manufacture of starch(Reda *et al.*2005). Sorghum is better suited to high temperature and

*(Sorghum bicolor (L) Moench).The treatments consisted of Poultry Manure at the rates of 0, 2, 4 and 6t/ha and N fertilizer (NPK) applied at 0, 30, 60, and 90kgN/ha. These treatments were factorially combined to give 16 treatment combinations and laid out in a randomized complete block design and replicated three times. Data collected during the experiment were subjected to analysis of variance (ANOVA) to determine the significant difference between treatments and the mean 6t/ha poultry manure and 90kg N/ha nitrogen fertilizer to sorghum significantly (P≤0.05) promoted growth and yield of sorghum better than the other treatments and all the treatments were better than the control. It was observed that, the application of 6t/ha poultry manure and 90kg N/ha nitrogen fertilizer increased plant height, number of leaves, leaf area, days to 50% flowering, physiological maturity, 1000 grain weight and grain yield were all significantly (P≤ 0.05) affected by the application of 6t/ha poultry manure and 90kgN/ha nitrogen fertilizer in the study area. Based on the result of this study, growing sorghum with the application of 6tons/ha of poultry manure in combination with nitrogen fertilizer at the rate of 90kg/ha should be adopted by farmers in the study area and further research should be carried out to determine the* best levels that give best results.

moisture stress conditions bio-chemically and physiologically than rice, wheat and barley. It can give useful yields in areas unfavourable to other cereal crops like rice, wheat and barley (Dowens,1992). Sorghum is adapted to a wide range of environmental and ecological conditions, having the ability to thrive in the hot, semi-arid, tropical and dry temperate areas of the world (Blum, 2004). The crop also grows on a wide range of soils: sand, loam, sandy-loam, saline and alkaline soils with a $P^H$ range of 4.0-8.5 (Aba *et al.*, 2004).Globally, sorghum production is estimated at about 64.6 million tons on a cultivated area of 43.8 million hectares in 2007 (Reda *et al.*, 2011). Now sorghum has reached the second position as feedstock for grain based ethanol after maize (Musa *et al.*, 2011). As the global population and fresh water demand is continuously increasing, dry land farming and sorghum crop are gaining importance. (Reda *et al,*. 2011), while the industrial demand for sorghum in Nigeria alone is estimated at 200,000 metric tonnes (Reda *et al.*,2005).About 50% of the total area devoted to cereal crops in Nigeria is occupied by sorghum. The area estimated at 6.86 million hectares extends north-ward from latitude $8^0$N and latitude $14^0$ N (Aba *et al.*, 2004). Consequently, Nigeria became the largest sorghum producer in the West African sub-region accounting for 71% of regional total sorghum output. Globally also, Nigeria leads in sorghum production for human consumption and has risen from its fifth position in 1994 (FAO, 1996) to be third largest sorghum producer in the world after USA and India where more than 90% of their sorghum harvest is used for animal feed (Obilana, 2005). The problem of soil fertility in the Northern States of Nigeria like most of sub-Saharan African countries is driven by a wide range of factors. The rapid increase in population growth impose more pressure on the land leading to cutting down of trees for shelter, fuel and farmland. This exposes the soil to adverse climatic factors and increases the rate of nutrient depletion with little or no commensurate increase in the amount of fertilizing elements in form of organic or inorganic fertilizers being added to the soil. Under continuous crop cultivation common in the savannah zone, the drain in soil nutrients is very high and the occurrence of nutrient deficiency becomes widespread. The high cost of inorganic fertilizers coupled with its poor distribution system and the low incomes of our peasant farmers who constitute about 75% of the population has made its widespread use difficult. Savannah soils on the other hand are low in fertility and therefore cannot satisfactorily support crops like sorghum without addition of fertilizers. Organic fertilizers are simple to apply and available locally while inorganic fertilizers are generally costly and not readily available to small scale farmers. This

necessitates the use of organic and inorganic fertilizer as a means of soil fertility restoration in order to determine the best combination that gives optimum growth and yield of sorghum in the study area. Analysis has shown that organic fertilizers, especially those of animal origin, besides the supply of major nutrients (NPK), also provide calcium, magnesium as well as micro-nutrients to the soil(Agboola and Unnama 1991). Therefore, the use of poultry manure and NPK fertilizer will have a positive impact towards reducing the problem of nutrient supply of the soil and consequently improve/increase the growth and yield of sorghum in the study area The objectives of the study are: To study the effect of organic fertilizer on the growth and yield of sorghum study the effect of inorganic fertilizer on the growth and yield of sorghum and to study the interaction between organic and inorganic fertilizers on the growth and yield of sorghum.

## MATERIALS AND METHODS

### Experimental Site

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi during the 2015 rainy season. It is located at latitude $11^0\,17'$ and longitude $9^047'$, 510m above sea level, in the northern guinea savanna agro-ecological zone of Nigeria.The climatic condition of the study area (Bauchi) is characterized by two main seasons; the rainy season spanning from April to October and dry season from November to March. The mean annual rainfall was 1000mm with a mean daily maximum temperature of $26^0$C (Kowal and Knabe, 1972). According to Lombin, (1983), the soil of the experimental site is sandy loam with $P^H$ range of 6.30-7.78.

### Experimental Materials

The materials used for the research consists of two types of fertilizers; organic fertilizer (poultry manure) which was obtained from a poultry farm in Bauchi and Nitrogen fertilizer (NPK 20:10:10) The sorghum used for the experiment was obtained from the Department of Crop Production, Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University Bauchi The treatments consisted of four levels of poultry manure (0, 2, 4, and 6t/ha) and four levels of NPK fertilizer (0, 30, 60 and 90kgN/ha) which was laid out in a randomized complete block design replicated three times. The plot size was 2x3m, distance between plots 0.5m while 1.0m was left as walk way between replications. The experimental site was cleared and harrowed to a fine tilt so as to provide a conducive environment for

crop growth using a tractor. Seed was planted in rows at 25x75cm which were later thinned to one plant per stand at two weeks after emergence. This gives a total of 8 stands per row with 36 stands per plot. The poultry manure used for the experiment was incorporated into the soil one week before sowing while the NPK fertilizer was applied in two split doses. Half was incorporated into the soil during sowing while the remaining half was applied at five (5) weeks after sowing. The fertilizers were weighed using an electronic weighing balance before they were being applied. Manual weeding was carried out at two (2) weeks after emergence and five (5) weeks after emergence using hoe Harvesting was carried out when the crop reached physiological maturity. Cutlass was used to harvest by cutting down the entire plant at maturity. The panicles were removed using knife manually and allowed to dry under the sun for one week. The dried panicles were then threshed manually with the use of a stick. Chaff was thereafter winnowed out and the grains separated. Data was collected from ten randomly selected plants from each plot during the research for the following parameters and they include the following: Plant Height (cm), Number of Leaves perplant ,Leaf Area ($cm^2$) Days to 50% flowering, Days to physiological maturity, 1000 grain weight (g) and Grain yield (kg/ha) All data collected during the experiment was subjected to analysis of variance (ANOVA) to determine the significant difference between treatments and the mean performance of each treatment. However, the treatment means were separated using Duncan's Multiple Range Test (DMRT).

## RESULTS AND DISCUSSION

### Effect of Poultry Manure and Nitrogen Fertilizer on the Growth Characters of Sorghum

### Plant Height (cm)

Table1, shows that there is a significant ($<0.05$) difference observed on plant height throughout the study period in which application of 6t/ha poultry manure and 90kg/ha nitrogen fertilizer proved to be better than all other rates used showed that increasing fertility of the soil through the use of organic and inorganic fertilizer increased the growth of sorghum. The result of this finding supports the earlier report of Sikora and Enkiri, (1999) who reported that combining organic fertilizer with sufficient Nitrogen fertilizer to meet crop requirement is an appealing alternative that utilizes fertilizers at rates lower than those of organic fertilizers and reduces the amount of Nitrogen fertilizers applied to soils. The increase in plant height could also be as a result of other favourable environmental factors or requirements for

production of sorghum. This is in line with the findings of Lilemo *et al*., (2005) who reported that the environmental factors that determine sorghum development and final yield are water, temperature, humidity, light and soil nutrients availability. He further reported that, because of its wide adaptability to a wide range of environmental and ecological conditions, sorghum gives useful yield in areas unfavourable to other cereal crops.Interaction of poultry manure and nitrogen fertilizer at 6 and 8 WAE indicated that poultry manure at 6t/ha and nitrogen fertilizer at 90kg/ha produced taller plants than all other rates used. The control on the other hand produced the shortest plants. The result of this finding is in line with the reports of Olayinka *et al*., (2007) who identified organic materials as good sources of soil amendments that can be used to increase the growth of sorghum plant and subsequently improve production.

## Number of Leaves

Table 2 shows a significant (<0.05) difference observation on the number of leaves throughout the study period at various levels of poultry manure and nitrogen fertilizer in which 6t/ha poultry manure and 90kg/ha nitrogen fertilizer proved to produce higher number of leaves in comparism to other treatments used revealed the importance of organic and inorganic fertilizer on the growth characters of sorghum. The result of this study is in agreement with the findings of Ismaeil *et al,.* (2012) in which he reported that results of growth attributes (plant height, number of leaves and leaf area index) of sorghum has significantly increased with increased rate of poultry manure with maximum number of leaves and leaf area index recorded under the highest rate. The nature of the soil in the study area could also be seen as a factor contributing to the number of leaves as confirmed by Lombin, (1993) where he reported that the impact of fertilizers on growth of cereals strongly depends on the soil.

## Leaf Area ($cm^2$)

Table3 showed a higher leaf area observed through the application of 6t/ha poultry manure and 90kg N/ha nitrogen fertilizer is as a result of the increase in plant growth as influence by fertilizer application. The increase in leaf area as a result of increase in application of fertilizer also indicated the importance of poultry manure and nitrogen fertilizer in cereal production. Sorghum grown with organic and inorganic fertilizer combination tend to promote larger surface area for sunlight and $CO_2$

absorption. This proved the result of Fagam *et al.,* (2009) who reported that increase in Nitrogen fertilizer increase growth characters of plant.

### Days to 50% flowering

Table 4 shows the result of days to 50% flowering. There was a significant ($P \leq 0.05$) difference observed in terms of number of days to 50% flowering indicated influence of poultry manure and nitrogen fertilizer in sorghum production. This might be as a result of increase in growth rate of the crop due to the addition of organic matter. The reduction in number of days to 50% flowering as a result of increase in fertilizer rate revealed the importance of nitrogen fertilizer in sorghum production. This result supports the report of Agboola and Unnama . (1991) that also showed a significant reduction in days to 50% flowering as a result of fertilizer application to sorghum grown with combined application of organic and inorganic fertilizer rather than mineral fertilizer alone. The result also conforms with the findings of Oseni, (2010) who reported a similar trend.

### Days to physiological maturity.

The results of the experiment carried out on days to physiological maturity in Table 4 showed that 6t/ha poultry manure and 90kgN/ha nitrogen fertilizer is better than all the treatments having recorded lower days to physiological maturity with increase in fertilizer application. This shows the importance of fertilizer as a basic component of many physiological processes in plants. The present findings is in agreement with the report of Marschner (2005) who stated that, nitrogen is a basic constituent of many compounds of physiological importance to plant metabolism.The contribution poultry manure and nitrogen fertilizer on reduction of days to physiological maturity might partly be due to enhanced growth and physiological processes of the crop as a result of the addition of nitrogen and organic matter by the fertilizer being applied. It also revealed the effect of fertilizer application on physical and chemical properties of soil which positively affects the growth and physiological maturity of sorghum. This is in agreement with the findings of Muhammad and Khattak, (2009) who reported a significant reduction in days to physiological maturity of sorghum in response to fertilizer application.

### 1000 Grain Weight (g)

The result showed in table 5 revealed that application of 6t/ha poultry manure and 90kgN/ha nitrogen fertilizer was observed to produce significantly ($P \leq 0.05$) heavier grains than the other treatments used. The control plots recorded the lowest 1000 grain weight among the treatments considered. This indicates the effect of poultry manure and nitrogen fertilizer on 1000 grain weight of sorghum. The result of this study may be due to the increase in the supply of essential nutrients which are important in the determination of yield components. The result agrees with the findings of Daniel *et al.*, (2010) who stated that application of organic fertilizer alone or in combination with mineral fertilizers led to increased yield and yield attributes compared to control. This is further confirmed by the report of Agbede *et al.*, (2008) who reported significant increase in sorghum panicle length and weights with the addition of poultry manure to the soil in a two-year experiment.

## Grain Yield (kg/ha)

Table 5 also shows the result of grain yield. The result of the experiment showed a significant ($P \leq 0.05$) difference with the application of 6t/ha poultry manure and 90 kg N/ha nitrogen fertilizer which gave higher yield than the other rates revealed that yield increases with increase in fertilizer application. This clearly indicates the importance of organic and inorganic fertilizer in the performance of sorghum. This result agrees with the report of Mandal *et al.,*(1992) who stated that organic fertilizer when used alone or in combination with inorganic fertilizer is found to be of great economic value ranging from growth and yield, weed and erosion control and reduction in expenditure. It could also be due to the importance of fertilizer in improving the physico-chemical properties of the soil. This result agrees with the findings of Agbede *et al.,* (2008) who reported that organic fertilizers especially poultry manure helps to significantly reduce soil bulk density and temperature and increases porosity and moisture content. Sanchez, (1979), further confirms this when he reported that fertilizers affect plant growth and yield by improving the physical and chemical properties of the soil which in turn influences growth and yield of sorghum. The higher yield recorded could also be attributed to the other yield components. This conforms with the report of Nagy, (1997), who stated that grain

yield is a product of the yield components, including number of plants per unit area, number of panicle per plant, panicle length and 1000 grain weight.

**Table 1: Effect of Poultry Manure and NPK Fertilizer on Plant Height (cm) of Sorghum *WAE***

| *Treatments* | 2 | 4 | 6 | 8 | 10 | At harvest |
|---|---|---|---|---|---|---|
| *Poultry Manure(t/ha)* | | | | | | |
| *0* | 19.68$^{d}$ | 41.26 | 80.38$^{d}$ | 100.47$^{d}$ | 169.50$^{d}$ | 245.63$^{c}$ |
| *2* | 21.78$^{c}$ | 47.39 | 81.29$^{c}$ | 104.05$^{c}$ | 173.48$^{c}$ | 258.18$^{bc}$ |
| *4* | 25.71$^{b}$ | 45.46 | 83.57$^{b}$ | 113.79$^{b}$ | 185.43$^{b}$ | 266.66$^{ab}$ |
| *6* | 29.78$^{a}$ | 49.63 | 94.85$^{a}$ | 134.22$^{a}$ | 197.32$^{a}$ | 286.13$^{a}$ |
| *LS* | ** | NS | ** | ** | ** | ** |
| *SE±* | 0.66 | 2.73 | 0.25 | 0.34 | 0.42 | 5.60 |
| *Nitrogen Fertilizer(kg/ha)* | | | | | | |
| *0* | 22.67$^{b}$ | 49.62 | 75.95$^{d}$ | 96.70$^{d}$ | 162.85$^{d}$ | 242.16$^{c}$ |
| *30* | 24.17$^{ab}$ | 41.48 | 83.08$^{c}$ | 103.77$^{c}$ | 175.29$^{c}$ | 262.07$^{b}$ |
| *60* | 25.49$^{a}$ | 44.35 | 88.24$^{b}$ | 119.54$^{b}$ | 188.50$^{b}$ | 281.6$^{ab}$ |
| *90* | 24.61$^{ab}$ | 48.29 | 92.80$^{a}$ | 132.52$^{a}$ | 199.11$^{a}$ | 270.73$^{a}$ |
| *LS* | ** | NS | ** | ** | ** | ** |
| *SE±* | 0.66 | 2.73 | 0.25 | 0.34 | 0.42 | 5.60 |
| *Interaction* | | | | | | |
| *P x N* | NS | NS | ** | ** | NS | NS |

LS = Level of significance, NS = Not significance, * and * = significant at 0.05 and 0.01 respectively.

Means followed by different letters are statistically different following DMRT

Table 2: Effect of Poultry Manure and NPK Fertilizer on Number of Leaves of Sorghum

| | *WAE* | | | | |
|---|---|---|---|---|---|
| *Treatments* | *2* | *4* | *6* | *8* | *10* |
| *Poultry manure (t/ha)* | | | | | |
| *0* | 3.68$^{c}$ | 5.08$^{c}$ | 7.13$^{b}$ | 8.96$^{c}$ | 9.82$^{d}$ |
| *2* | 3.57$^{b}$ | 4.88$^{b}$ | 7.00$^{c}$ | 8.77$^{b}$ | 9.78$^{c}$ |
| *4* | 3.60$^{b}$ | 4.99$^{b}$ | 7.13$^{b}$ | 8.88$^{b}$ | 9.91$^{b}$ |
| *6* | 3.88$^{a}$ | 5.34$^{a}$ | 7.34$^{a}$ | 9.37$^{a}$ | 10.63$^{a}$ |
| *LS* | ** | ** | ** | ** | ** |
| *SE±* | 0.13 | 0.16 | 0.19 | 0.27 | 0.24 |
| *Nitrogen fertilizer (kg/ha)* | | | | | |
| *0* | 3.62$^{b}$ | 5.04$^{b}$ | 7.08$^{b}$ | 8.78$^{b}$ | 9.75$^{b}$ |
| *30* | 3.65$^{ab}$ | 4.98$^{c}$ | 7.02$^{b}$ | 8.95$^{b}$ | 9.84$^{b}$ |
| *60* | 3.63$^{a}$ | 5.14$^{a}$ | 7.19$^{a}$ | 9.07$^{a}$ | 10.28$^{a}$ |
| *90* | 3.83$^{c}$ | 5.13$^{a}$ | 7.33$^{a}$ | 9.18$^{a}$ | 10.27$^{a}$ |
| *LS* | * | ** | NS | ** | ** |
| *SE±* | 0.13 | 0.16 | 0.19 | 0.27 | 0.24 |
| *Interaction* | | | | | |
| *P x N* | NS | NS | NS | NS | NS |

LS = Level of significance, NS = Not significant, * and ** = significant at 0.05 and 0.01 respectively

Means followed by different letters are statistically following DMRT

Table 3: Effect of Poultry Manure and NPK Fertilizer on Leaf Area (cm²) of Sorghum

| *WAE* | | | | |
|---|---|---|---|---|
| *Treatments* | 4 | 6 | 8 | 10 |

| | | | | |
|---|---|---|---|---|
| *Poultry Manure (t/ha)* | | | | |
| *0* | 208.50$^{c}$ | 266.69$^{d}$ | 440.98$^{d}$ | 553.61$^{c}$ |
| *2* | 203.56$^{b}$ | 258.34$^{c}$ | 432.90$^{c}$ | 554.31$^{b}$ |
| *4* | 210.97$^{ab}$ | 268.70$^{b}$ | 446.54$^{b}$ | 557.35$^{a}$ |
| *6* | 223.34$^{a}$ | 314.58$^{a}$ | 499.42$^{a}$ | 559.72$^{b}$ |
| *LS* | ** | ** | ** | ** |
| *SE±* | 14.39 | 20.87 | 24.61 | 9.42 |
| *Nitrogen Fertilizer (kg/ha)* | | | | |
| *0* | 215.00$^{ab}$ | 258.62$^{ab}$ | 456.26$^{b}$ | 553.55$^{b}$ |
| *30* | 201.12$^{c}$ | 272.62$^{b}$ | 464.72$^{a}$ | 565.25$^{a}$ |
| *60* | 208.78$^{b}$ | 283.22$^{a}$ | 432.39$^{a}$ | 560.83$^{a}$ |
| *90* | 221.37$^{a}$ | 293.51$^{a}$ | 466.47$^{b}$ | 545.37$^{b}$ |
| *LS* | NS | * | ** | ** |
| *SE±* | 14.39 | 20.87 | 24.61 | 9.42 |
| *Interaction* | | | | |
| *P x N* | NS | NS | NS | NS |

LS = Level of significance, NS = Not significant, * and ** significant at 0.05 and 0.01 respectively

Means followed by different letters are statistically different following DMRT

**Table 4: Effect of Poultry Manure and NPK Fertilizer on Number of Days to 50% Flowing and Physiological Maturity of Sorghum**

*Parameters*

| *Treatments* | 50% flow. | PM |
|---|---|---|
| *Poultry Manure (t/ha)* | | |
| *0* | 72.46$^{a}$ | 106.77$^{a}$ |
| *2* | 72.84$^{a}$ | 106.75$^{b}$ |
| *4* | 73.95$^{b}$ | 106.33$^{c}$ |
| *6* | 69.87$^{c}$ | 104.99$^{d}$ |

| | | |
|---|---|---|
| *LS* | ** | ** |
| *SE±* | 0.39 | 0.55 |
| ***Nitrogen Fertilizer (kg/ha)*** | | |
| *0* | 72.98[a] | 106.66[a] |
| *30* | 71.98[b] | 106.76[c] |
| *60* | 72.38[c] | 105.76[c] |
| *90* | 71.77[d] | 106.14[d] |
| *LS* | ** | ** |
| *SE±* | 0.28 | 0.55 |
| ***Interaction*** | | |
| *P x N* | NS | NS |

LS = Level of significance, NS = Not significant, * and ** = Significant at 0.05 and 0.01 respectively

Means followed by different letters are statistically different following DMRT

**Table 5: Effect of Poultry Manure and NPK Fertilizer on 1000-grain weight and yield of sorghum**

***Parameters***

| ***Treatments*** | 1000-grain weight(g) | Yield(kg/ha) |
|---|---|---|
| ***Poultry Manure (t/ha)*** | | |
| *0* | 17.63[c] | 1165.36[d] |
| *2* | 17.90[c] | 1302.29[c] |
| *4* | 19.87[b] | 1578.01[b] |
| *6* | 22.31[a] | 1757.86[a] |
| *LS* | ** | ** |
| *SE±* | 0.35 | 24.35 |
| ***Nitrogen Fertilizer (kg/ha)*** | | |
| *0* | 18.41[c] | 1386.18[dc] |
| *30* | 19.02[b] | 1398.38[c] |

| | | |
|---|---|---|
| *60* | 19.98[b] | 1522.46[b] |
| *90* | 20.31[a] | 1496.51[a] |
| *LS* | ** | ** |
| *SE±* | 0.35 | 24.35 |
| ***Interaction*** | | |
| *P x N* | NS | NS |

LS = Level of significance, NS = Not significant, * and ** significant at 0.05 and 0.01 respectively

Means followed by different letters are statistically different following DMRT

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