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Effect of Poultry Dropping and Urea Fertilizer On Growth Performance and Sorghum (*Sorghum bicolor* (L.) Moench) Dry Matter

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ABSTRACT

Pot experiment was carried out to determine the integrative effect of Urea (46:0:0) fertilizer amended with poultry dropping, on Sorghum growth parameters and dry matter at the Teaching and Research Farm of the Department of Agricultural Education Federal College of Education, Zaria. Poultry droppings were applied at 0, 9, 18, and 27tha^{-1} along with 60kg/ha Urea (46%) fertilizer mixed with 10kg of soil, The four treatments were replicated 3 times to give 12 pots except for control. SAMSORG 53 Sorghum variety purchased from InstitudeforAgricultural Research Samaru was sowed as the test crop. The experimental design was a completely randomized design (CRD). Data on stem girth (cm), leaf number, plant height(cm), and dry matter yield (g) were subjected to analysis of variance (ANOVA) and means were separated using the least significant difference (LSD). At 5% level of probability. Results obtained indicated that the soil used is Sandy loam. The application of poultry dropping at 27tha^{-1} had the tallest Sorghum plant height with a mean of 62.54cm. compared with control treatment. However,Sorghum leaf number was significant at 8WAS with poultry dropping at 27tha^{-1} had the highest leaf number of 8.0. The highest Sorghum dry matter yield with a mean of 40.20g was obtained with poultry dropping at 27t/h application rate. The Urea(46%) fertilizer amended with poultry dropping, significantly improved vegetative and post-anthesis development, in addition to soil physical and chemical properties, under continuous cultivation applications of poultry dropping by smallholder farmers can be a cost-effective organic input for sustainable sorghum production thereby reducing the dependence and cost reduction on mineral fertilizer among smallholder in the rural communities of the Savannah region of Nigeria.

Keywords: Sorghum, smallholder, Poultry dropping, Urea, Dry matter, smallholder

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1. INTRODUCTION

Sorghum (*Sorghum bicolor* L Moench.) belongs to the grass family Poaceae. In Nigeria, it is the fourth most important cereal crop after wheat, rice, and maize (Venkateswara, *et al.,* 2019). Sorghum can be cropped under diverse rainfall and temperature patterns. This makes Sorghum an attractive option for both farmers and consumers.

This is especially so in the Savanna region of Nigeria, where it is adaptable for its production (Jerie & Ndabaningi, 2011; Ejeh & Ikpe, 2022). Sorghum is one of the major dietary energy suppliers, that provide a significant amount of protein, starch, minerals (Potassium and Calcium), and vitamins (vitamins A and C) (Ismaila, *et al.,* 2010). It is consumed in forms, such as pastes, noodles, cakes, breads, and drinks (Berenji & Dahlberg, 2004). The bran, husk, plant parts, and other residues (after processing) can be useful as animal feeds and also used to culture micro-organism wax syrup and gum when extracted for industrial purposes (Mohammed-Lawal & Atte, 2006).

The continuous demand for Sorghum in Nigeria, is reflected in the 5.82 million hectares put to cultivation. The annual output is estimated at 6.9 metric tonnes, accounting for about 71% of Sorghum output in West Africa and 35% of total regional output in Africa (Ogbonna, 2011). In Nigeria despite the increase in land cropped with Sorghum, production has not kept pace with demand, due to a severely low yield of 1.23t/ha on farmers' fields which is relatively low compared to the yield of 1.46t/ha world average under good crop husbandry. The Sorghum low yield output of ($\leq$ 1.0 t/ha) could be attributed to production constraints such as continuous cultivation, without adequate application of either organic or mineral fertilizers to the soil, resulting in low soil fertility that may not have sustained production in the Savannah region of Nigeria. (Waddington *et al*. 2010; Abdullahi *et al.,* 2019; Ghosh*, et al.,* (2022).

Mineral fertilizer application is critical to increasing or maintaining Sorghum growth and yields on a single piece of farmland. However, the increasing cost of mineral fertilizer has led to a decline in its use by smallholder farmers, who hardly apply adequate quantity on their farms (Sene *et al.,* 2023) The application of mineral fertilizers alone can contribute to soil acidity, and low soil organic matter (SOM) as well as the degradation of soil physical and chemical properties. Sorghum farmers in the Savanna region of Nigeria can maximize and utilize cost-effective and available organic input resources, by exploring alternative nutrient sources such as poultry droppings, a rich resource of organic fertilizer, that is local, handy, and readily available (De, 2022). Poultry dropping application on farms will not only replenish soil nutrients but also contribute to waste management by utilizing poultry by-products for increased Sorghum productivity. The combined approach of Urea fertilizer and poultry dropping application on farms can be beneficial in terms of stabilizing the soil, and a reduction in the cost of mineral fertilizer purchase, while ensuring that necessary nutrients are supplied in adequate amounts (Makinde *et al.,* 2007). The study was carried out to determine the effect of Urea fertilizer amended with poultry droppings on Sorghum growth performance and dry matter yield matter.

2. MATERIALS AND METHODS

Soil Sampling and Laboratory Analysis

To characterize the soil, 120kg bulk soil was randomly collected from 0-20cm soil sampling depth using an Auger, from the Teaching and Research Farm of Federal College of Education, Zaria. The soil samples were crushed and passed through a -2mm mesh before the analysis. The soil samples were subjected to analysis at the Soil Science laboratory of the Institute for Agricultural Research (IAR) Zaria. Soil particle size analysis according to Klute method (1986). Soil pH was determined by using the Pye Unicam pH meter, both in water (H_2O) and calcium chloride ($CaCl_2$) in a soil solution ratio of 1:2.5. Organic carbon was determined by Walkley and Black wet oxidation method (Nelson & Sommers, 1982).

Total nitrogen was determined by the micro-Kjeldahl technique (Bremner & Mulvaney, 1982). Available phosphorus was determined by the Bray 1 method (Bremner and Mulvaney, 1982). Exchangeable bases were extracted by 1.0 N Ammonium Acetate (NH_4OA_c) saturation method (Chapman, 1965).

Treatment and Experimental Design

Poultry droppings were obtained at the Agricultural Education Livestock Section, air-dried, and, crushed using a wooden mortar and pestle and applied into twelve (12) plastic pots each containing 10kg of soil at the rate 0, 9, 18, and 27t/ha with Urea (46:0:0) fertilizer applied at 60kg/ha and the control where there was no treatment applied. This is equivalent to 0, 41, 82, 123g of poultry droppings and 1.82g of Urea (46:0:0) fertilizer. The treatments were arranged in a completely randomized design (CRD), irrigated, and Sorghum (*Sorghum bicolor.*) was sowed*,* at three seeds per pot, which were thinned to two plants per pot, two weeks after germination. Sorghum plant height was taken from the surface of the soil to the epical tip of the plant using a measuring tape. The average plant height was expressed in centimeters (cm). The venier caliper was used to determine sorghum stem girth. The total number of leaves per plant was counted for each treatment. The Sorghum plant material was harvested 40 days after sowing, oven dried to determine Sorghum dry matter yield.

3. RESULTS AND DISCUSSION

Soil particle size data (Table. 1) showed that sand was the dominant fraction with a value of 620g/kg. The dominance of sand fraction may be attributed to the nature of the parent material; basement complex rocks from which the soils were formed, are rich in quartz mineral and also an essential component in granite and sandstone (Malgwi *et al.,* 2000; Jimoh, *et al.,* 2011). The dominance of sand fractions relative to silt and clay allowed for root growth and soil aeration, consequently low water and nutrient capacity (Wapa *et al.,* 2014). The pH value of 6.52 is an indication of optimal nutrient availability, which is ideal for most crops including Sorghum (Dayton, *et al.,* 2011). Organic carbon (0.54g kg^{-1}) and total nitrogen (0.17g kg^{-1}) were both low. The low organic carbon content and high sand content, exhibit reduced aggregation, water retention, and poor physical stability of the soils, indicating a decrease in crop productivity at the Teaching and Research farm (Salako, 2003; Shehu *et al.,* 2015). Available phosphorous (4.15 mg kg^{-1}) was high, but low when compared to the mean value of 6.0 mg kg^{-1} generally reported for the Savannah region (Manu, *et al.,* 1991). Potassium (0.19 cmol kg^{-1}), Calcium (8.92 cmol kg^{-1}), values indicate that the soils were low in nutrients. The low contents of these nutrients indicate that the soils might have lost these cations through leaching and other weathering processes due to the sandy nature of the soils.

Sorghum growth Parameters

Sorghum stem girth represents the growth and resistance of plants (Table. 1) was observed to be significant ($P<0.05$) for 3, 4. 5, 6 7, and 8WAS, but not at 2WAS. Sorghum stem girth showed an increase significantly in all the treatments with an increasing rate of poultry dropping except for control. The highest stem girt of 3.5cm was recorded with 27t/ha application rate at 8WAS compared with the control treatments. Stem diameter was significantly affected by the increasing application rate of poultry manure, this indicates that poultry dropping affected the growth and resistance Sorghum plant (El-Samnoudie, *et al,.* 2019). Similarly, Ismaeil *et al.,* 2012 reported a significant effect on stem diameter of forage Sorghum by increasing the level of poultry manure.

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Table 1: Physical and chemical properties of soil at the study site

Soil Properties		Value
Soil Particle size (g kg^{-1})		
Clay		100
Silt		280
Sand		620
Textural class		Sandy Loam
Chemical properties		
pH (H_2O: 1:2.50 w/v)		6.52
pH 0.01M $CaCl_2$1:2.50 w/v)		5.41
Avail. P (mg kg^{-1})		41.48
Organic C (g kg^{-1})		0.54
Total N (g kg^{-1})		0.17
Exchangeable Cations (cmol kg^{-1})		
K	“	0.19
Ca	“	8.92
Mg	“	1.02
Na	“	1.45
CEC (cmol kg^{-1})		13.40

Table 2: Effect of Poultry dropping and Urea on Sorghum stem girth (cm)

Treatment	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS
0t/ha	1.78	1.14^{c}	1.48^{b}	1.75^{b}	1.68^{b}	1.86^{b}	2.11^{b}
9t/ha	2.10	1.70^{bc}	2.09^{ab}	2.39^{a}	2.64^{b}	2.82^{a}	2.91^{a}
18t/ha	2.20	1.72^{b}	2.46^{a}	2.98^{a}	2.68^{a}	3.35^{a}	3.07^{a}
27t/ha	2.20	2.32^{a}	2.53^{a}	2.75^{a}	3.01^{a}	3.44^{a}	3.50^{a}
SED	0.21	0.64	0.22	0.21	0.23	0.29	0.27
LSD	NS	*	*	*	*	*	*

WAS: Weeks After Sowing
Means with the same letter under the same column are not significantly different ($P \leq 0.05$) using LSD.

Sorghum Leave Number

The effect of poultary dropping on Soghun leaf number (Table 3) was significant ($P<0.05$) at 2, 3, 4, 6, 7, and 8 WAS, but was not significant at week 5. Leaf number increased with increase application rate 0t/ha to 27t/ha. Generally, nutrients such as organic-N in poultry dripping is mineralized and available may have improved Sorghum growth, and development, (Awodun, 2007).

Table 3: Effect of Poultry dropping and Urea on Sorghum leaf number.

Treatment	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS
0t/ha	3.33^{c}	5.55^{b}	5.66^{b}	5.66	6.66^{b}	7.00	6.66^{b}
9t/ha	4.66^{ab}	5.33^{b}	6.66^{a}	6.66	7.33^{ab}	7.77	7.66^{a}
18t/ha	4.33^{bc}	6.66^{a}	7.00^{a}	6.66	8.00^{ab}	7.66	7.66^{a}
27t/ha	5.66^{a}	6.33^{ab}	7.00^{a}	7.33	8.33^{a}	8.00	8.00^{a}
SED	0.42	0.41	0.24	0.61	0.56	0.78	0.35
LSD(0.05)	*	*	*	NS	*	NS	*

WAS: Weeks After Sowing
Means with the same letter under the same column are not significantly different ($P \leq 0.05$) using LSD
Sorghum plant Height

Sorghum plant height (Table. 4) was significant (P< 0.05). for each of the 8 weeks after sowing. Sorghum plant height increased with increasing application rate from control 0t/ha to 27t/ha, of poultary dropping. The highest plant height of 32.72cm at was obtained with 18t/ha application rate at week 4 after sowing. However, it decreased to 31.60cm at 27t/ha application rate. Plant height is vital to crop production, it displays the relative growth and vigor of crop plant.

The increased sorghum plant height could be attributed to the dominance of sand fractions, thereby increasing the porosity and moisture content and consequently, enhancing the root growth, water, and nutrient uptake. In addition, poultry dropping mineralized other essential nutrients; macro and micronutrients, with the nitrogen supplied by Urea mineral fertilizer source. This corroborates the findings of Arunah *et al.,* (2006) who reported that apart poultry dropping doesn't only supply other nutrients for plant growth but was superior in supplying nitrogen, and critical to deterring sorghum yield.

Table 4: Effect of Poultry dropping and Urea on Sorghum plant height (cm)

Treatment	2WAS	3WAS	4WAS	5WAS	6WAS	7WAS	8WAS
0t/ha	6.55^{c}	14.63^{b}	19.11^{b}	22.53^{b}	23.45^{b}	26.39^{b}	38.29^{b}
9t/ha	7.50^{b}	19.52^{ab}	23.47^{b}	30.25^{ab}	32.45^{ab}	37.02^{a}	54.50^{a}
18t/ha	7.86^{a}	23.55^{a}	32.72^{ab}	32.72^{ab}	34.65^{ab}	40.76^{a}	58.00^{a}
27t/ha	8.10^{a}	27.77^{a}	31.60^{a}	34.70^{a}	36.94^{a}	40.06^{a}	62.54^{a}
SED	0.10	2.09	2.28	3.25	3.39	1.52	4.19
LSD(0.05)	*	*	*	*	*	*	*

WAS: Weeks After Sowing
Means with the same letter under the same column are not significantly different (P ≤ 0.05) using LSD.

Sorghum Dry Matter

The effect of poultry dropping on Sorghum dry matter (Table. 5) showed an increase in Sorghum dry matter with increasing poultry dropping application rate. The highest Sorghum dry matter mean value of 40.20gramms at 27t/ha application rate suggests, that the inorganic fertilizer made available nutrients, needed by the crop during the early growth stages, while the poultry dropping mineralization to release nutrients needed by the crop in its latter stage of growth.

Thus, the increased availability and N from the Urea (46:0:0) fertilizer, significantly improved the vegetative growth of Sorghum, which could have resulted in the high dry matter weight. Similarly, the combined application of inorganic fertilizer and poultry dropping significantly increased plant height, and dry matter indicating that the integrative application of poultry dropping was better than either Poultry dropping or inorganic mineral fertilizer alone (Amujoyegbe *et al*., 2007).

Table 5: Effect of Poultry dropping and Urea on Sorghum Dry Matter (grams)

Treatment	0t/ha	9t/ha	18t/ha	27t/ha	SED	LSD (0.05)
Means	15.46^{c}	21.56^{bc}	26.90^{b}	40.20^{a}	3.09	*

Means with the same letter in the same row are not significantly different (P ≤ 0.05) using LSD

4. CONCLUSION AND RECOMMENDATION

The application of Urea (46:0:0) fertilizer amended with poultry dropping nutrient resource is suggestive of improved vegetative and post-anthesis development, of the Sorghum plant as well as soil physical and chemical properties, and a reduction on dependence on mineral fertilizer, due to scarcity and increasing cost. However, economic analysis of poultry dropping may be important to determine its attractiveness and adoption for crop production, especially in the Savanna region of Nigeria. Therefore, study recommended that smallholder farmers should utilize poultry droppings as a valuable source of organic manure to enhance soil fertility, particularly on acidic soils.

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