Effects of Manure Types on The Emergence and Seedlings Growth of Amaranths in A Sahelian Savanna Region of Nigeria

MAHMUD SANI[1], BABAYO A. AHMAD[2], SUFIYANU SANI[3]
[1, 2] *Department of Agronomy, Federal University Gashua, Yobe State Nigeria*
[3] *Department of Soil Science, Federal University Dutsin-Ma, Katsina State, Nigeria.*

Abstract- Data on the Yobe state Sahelian soils' based resources and potentials are among the most limiting information in the Nigerian soil science literature. The objectives of this study are to evaluate the effects of different organic manures (cow dung and poultry droppings) on seed emergence and growth performance of amaranths plant in the Sahelian region of Yobe State, Nigeria. The study consists of 3 treatments, which include control (no manure), cow dung, and poultry droppings. These were laid out in a randomized complete block (RCBD) design, replicated three times. Seedling emergence and growth performance data were collected on plant height (cm), number of leaves, and leaf area index (cm^2) at seedling emergence, 20 days after germination, and 40 days after germination. From the results, the poultry dropping was recorded to have the highest value for all the growth parameters; plant height (14.23cm), number of leaves (17.00) and leaf area index (8.60cm^2). The experimental results of this study have shown that the application of poultry droppings has the tendency to induce higher growth performances and, therefore, it is recommended for farmers to use it so as to obtain higher growth indices of amaranths in the Sahel.

Indexed Terms- Amaranths, Manure, Seedlings, Gashua, Yobe state

I. INTRODUCTION

Amaranth is a genus of annual herbs belonging to the family *Amaranthaceae* (Oguntade *et al*., 2013). Amaranths consist of 60–70 species (Xu & Sun, 2001) and include at least 17 species with edible leaves (Grubben & Denton, 2004). Although, several species are often considered weeds, cultures around the world value amaranths as leafy vegetables, cereals, and ornamentals (Bello, 2017). Originating from Central and South America, Amaranth has been cultivated for more than 8,000 years, dating back to Mayan, Incan, and Aztec civilizations (Grubben, 2004; Yarger, 2008). In Nigeria, as in most other tropical countries of Africa where the daily diet is dominated by starchy staple foods, vegetables are the cheapest and most readily available sources of important proteins, vitamins, minerals, and essential amino acids (Onwordi *et al*., 2009). African leafy vegetables are increasingly recognized as possible contributors of both micronutrients and bioactive compounds to the diets of populations in Africa (Smith, 2005). Four categories of amaranth are presently recognized. These are the grain, vegetable, ornamental, and weed categories, but many fall into more than one category. Vegetable amaranths grow very well in the hot and humid regions of Africa, Southeast Asia, China and India and are represented by *Amaranth hybridus*, *Amaranth tricolor* (tambala*), Amaranth viridus, Amaranth dubius, Amaranth cruentus, Amaranth edulis* and *Amaranth blitum* (Pospisil *et al*., 2009). Although, *Amaranth caudatus* is a grain type, it is often grown more as an ornamental leaf (Pospisil *et al*., 2009; Yarger, 2008). Weedy species are represented by *Amaranth retroflexus* (redroot pigweed*), Amaranth albus* (tumbleweed) and *Amaranth spinosus* (spiny amaranth) (Yarger, 2008). Although amaranth has been regarded as drought tolerant; the precise mechanism involved is not well understood. The crop (Amaranth) is adapted to a variety of soil types; it performs best in fertile, well-drained, and deeper soils. Loose and friable soils with high organic matter content are ideal for planting. The Amaranth requires both organic and inorganic fertilizer for proper growth and yield (Yarger, 2008)

Cow dung are material consisting of the faeces and urine of domestic livestock with or without accompanying litter such as straw, hay or bedding used to fertilize crop lands. Manure is rich in organic matter or humus and thus improved the soil capacity to absorb water and adsorb nutrients at exchange complexes (Grubben and Denton, 2004). Organic fertilizers have been used for many centuries whereas chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution.

Located in the Sahel Savannah Agro ecological zone, in the northern parts of Yobe State of North Eastern Nigeria, Gashua is a predominantly farming and fishing community. Despite the unfavorable climatic condition of the place, and Even though average annual rainfall is low, it is important to know that most of the soil in Gashua are very fertile and suitable for cultivation of many variety of crops such as; cereal, tubers, fruits, and vegetable which include both leafy vegetable which Amaranth is also one of the leading plant (Alhassan *et al*., 2018). The climate of Gashua is usually hot and dry for the greater part of the year reaching its peak between March and April. The length of the wet season is about 120 days. Rain season usually start from June and end in September with the rainfall reaching between 500 to 1000mm. The topography and relief of Gashua can be described as generally flat, and the most important geography feature of the Gashua is its famous River Yobe (FDALR, 1990). Greater part of Gashua was covered by a number of rivers E.g.: River Yobe which usually flood the area and empty into the main river which itself empty into the great Lake Chad.

In Nigeria, with inorganic fertilizers being costly and sometimes scarce, subsistent farmers find it economically impossible to apply enough for good growth (Van Asten *et al*., 2003). These Farmers depend largely on locally sourced organic fertilizers on one hand (Makinde *et al*., 2010). On the other hand, huge amount of organic wastes such as poultry waste, animal excreta, sewage sludge, refuse soil and palm oil mill effluent are generated and heaped on damp sites, posing potential environmental hazard (Agboola & Omueti, 1982). Incorporating these wastes materials into the soil for crop production would serve as source of organic fertilizer to buildup an organic matter layer that is needed for a steady supply of nutrients in tropical soils (Agboola and Omueti, 1982).

Vegetable are the cheapest source of many nutrients which are responsible for normal biochemical and physiological functions. It also helps in reducing the risk of chronic diseases in the tropics. To enhance the optimal production of this nutrient and phytochemical source, an appropriate use of fertilizer has to be employed. However, organic material varies considerably in the concentration of nutrient they contain and the rate at which these nutrients are released for the plant uses. Therefore, some organic manures are better for certain situation than the others and different material need to be applied at different rate to supply the correct amount of plant nutrient (Agboola & Omueti, 1982). Hence, it is necessary to evaluate the effect manure types will have on the growth, performance of amaranths especially in the Sahel, where little information is known in the literature. The objectives of this study therefore, are to evaluate the effect of different organic manure (cow dung and poultry dropping) on seed emergence and growth performance of amaranths plant

II. MATERIALS AND METHODS

- Study Area:

The field experiment was conducted at Biological Garden Federal University Gashua, Yobe State. On latitude 12053.031'N and longitude $011^{0}00.761$'E in the Nigerian Sahel savannah agro ecological zone. The Nigerian Sahel spans over a significant in land area in northern Yobe. Borno and Adamawa state (Sani *et al*., 2019). The soil of the study area is classified as Alfisols according to USDA system and predominantly Aeric Tropaqualfs characterized by deep and imperfect drainage, and derived from alluvial weathered-Basement complex parent materials of sedimentary origin (FDALR, 1990). The climate of Sahel was Aw (Koppen system) signifying tropical wet and dry seasons (Sani *et al*., 2019). The cumulative annual rainfall in the past three seasons in the study areas ranged from 550mm to 750mm as a unimodal occurrence between May and October, with an average annual temperature range of 27^{o}c - 41^{o}c across the study area (Shehu *et al.*, 2018).

- Experimental Design and Fertilizer Treatment:

The experiment included three (3) fertilizer treatments for Amaranth which are in factorial arrangement fitted into a randomized complete block design (RCBD) and replicated three times. Hence, the experiment had a total of nine (9) experimental plots each plots is measured 2m by 3m. The treatments are Control (no manure), 0.833 tons/ha poultry manure, and 0.833 tons/ha cow dung.

- Sampling:

Surface soil sample was taken from the experimental site at a depth of 0 – 15cm at land preparation and at 2 weeks after manure application using the zigzag method (Adugna & Abegaz, 2015). The sample was collected from eighteen (18) points and bulked to form a composite sample. The composite sample was air-dried, crushed and sieved through a 2mm mesh sieve and stored for chemical analysis. The poultry manure was collected at Department of animal science Federal University Gashua poultry farm. The cow dung was collected at Department of Animal Science Federal University Gashua farm.

- Laboratory Analysis:

The sampled soil and manure were analyzed at the soil and water laboratory, Faculty of Agriculture, Federal University Gashua (FUGA), and the soil science department of the Institute of Agricultural Research, Ahmadu Bello University Zaria, Nigeria. The following parameters were analysed using the standard referred methods for Particle size analysis (Sani, 2018), pH (in water) (Mitchell & Soga, 2005), Organic carbon (Walkley & Black, 1934), Organic matter, Available phosphorus using Extractable Phosphate Bray and Kurtz –Method (Department of Sustainable Natural Resources, 1995), Kjeldhal Total nitrogen (Bouajila & Sanaa, 2011), Cation Exchange Capacity (CEC) by adopting (Choo & Bai, 2016), and Exchangeable bases as in (Burt, 2014).

- Agronomic practices:

Planting and Management:

2kg/ha of seed were broadcasted evenly on the beds after mixing it with 10% parts of sand.

Preparation of the field

The field is prepared to a fine tilt and form beds of 2x3m size. After germination, the seedlings were thinned to have a spacing of 12–15 cm.

Collection for Growth Performance

Data were first collected at germination day (GD) and subsequently at 20 days and 40 days after germination (20 DAP).

Ten (10) randomly selected plants were tagged and used in each plot for data collection during the first and subsequent data collections.

Data collected includes percentage of seedlings Emergence, plant height, number of leaves, and leaf area index. Plant height was measured from the base of the stem (surface of the soil), up to the apex of the leaf. Plant height was measured using a measuring tape for the ten tagged plants per plot and the average was computed.

The number of leaves was counted for the ten tagged plants of each plot, and the average number of entries was computed. The Leaf Area (LA) was computed by multiplying the Leaf Length (LL) by the Leaf Width (LW) in cm2. An average of the ten records was then taken.

Calculation; Leaf Area = (Leaf Length × Leaf Width).

Statistical analysis

Analysis of variance (ANOVA) was conducted using the Statistical Tool for Agricultural Research (STAR®) Version 2.8.

III. RESULTS AND DISCUSSION

Table 1: Physico-chemical properties of pre manure application soil of the study area

Soil Parameters	Value
Particle Size Distribution	
Clay (%)	16
Silt (%)	28
Sand (%)	56
Textural class	Sandy loam
Phsico-Chemical Properties	
Available Phosphorus (mg/kg)	0.48
Organic carbon (%)	0.37

Organic matter (%)	0.52
Bulk density (gcm^{-3})	1.38
Total Nitrogen (%)	0.70
Exchangeable Bases	
Ca ($cmolkg^{-1}$)	8.85
Na ($cmolkg^{-1}$)	0.87
K ($cmolkg^{-1}$)	0.20
CEC ($cmolkg^{-1}$)	5.1

Source: Soil Science laboratory, Institute for Agricultural Research, Zaria.

Table 1 shows the physico-chemical properties of the soil before the application of soil amendments (manure). The soil was found to be sandy loam (LS) texture, the soil particle size distribution fall in the sandy range classified by Hill Laboratories (2007). Sandy ranged soil indicate a high degree of weathering and clay eluviation from the surfaces layer (Sani *et al*., 2019) it is difficult to detect such minor and progressive changes using conventional methods. The findings of on the experimental site soil conformed to those reported by Alhassan et al., (2018) on Sahelian savannah soils of Bade, Nigeria. The soil was found to be sandy loam (LS) texture. The soil particle size distribution falls within the sandy range classified by Hill Laboratory (2010). Sandy ranged soil indicates a high degree of weathering and clay eluviation from the surface layer (Nakao *et al.*, 2009). It is difficult to detect such minor and progressive changes using conventional methods. The findings on the experimental site soil conformed to those reported by Alhassan *et al*., (2018) on Sahelian savannah soils of Bade, Nigeria.

Physico-chemical properties of pre manure application soil of the study area indicate that the soil has available phosphorus=0.48, Organic Carbon=0.37, Organic Matter=0.52, Bulk Density=1.38, Total Nitrogen=0.70. Whereas the exchangeable bases show that Calcium=8.85, Sodium=0.87, Potassium=0.20, and CEC=5.1.

Physico chemical properties of the post manures application soil

Table 2: Physico-chemical properties of post manure application soil of the study area

Parameters	Values	
	Cow Dungs treated plots	Poultry droppings treated plots
Particle Size Distribution		
Clay (%)	17	12
Silt (%)	31	36
Sand (%)	52	52
Textural class	Sandy loam	Sandy loam
Physico-Chemical Properties		
Available Phosphorus (mg/kg)	0.51	0.53
Organic carbon (%)	0.58	0.47
Organic matter (%)	0.52	0.68
Bulk density	1.38	1.20
(gcm^{-3})	0.73	0.74
Total Nitrogen (%)		
Exchangeable Bases		
Ca ($cmolkg^{-1}$)	8.88	7.83
Na ($cmolkg^{-1}$)	0.92	0.79
K ($cmolkg^{-1}$)	0.23	0.26
CEC ($cmolkg^{-1}$)	5.3	6.6

Source: Soil Science Laboratory, Institute for Agricultural Research, Zaria.

Table 2 shows the physico-chemical properties of the post manure application soil of the study area where there is a change in variation between cow dung and poultry dropping manure. The variation is due to the different nutrient and micro-nutrient levels in the manure. The results in table 2 showed the physico-chemical properties of the cow dung used in the experimental site had BD = 1.38, AP = 0.51, OC = 0.58, OM = 0.52, TN = 0.73. whereas the exchangeable bases for cow dung used are: Ca = 8.88, Na = 0.92, K = 23, CEC = 5.3. Result showed for physico-chemical properties of poultry dropping used for the experimental site had: BD=1.20, OC=0.47, AP=0.53, OM=0.68, TN 0.74. Whereas the exchangeable bases for poultry dropping used are: Ca=7.83, Na=0.79, K=0.26, CEC=6.6. This attest to a report mentioned in Bouajila & Sanaa (2011).

The variation occurs do to the different nutrient and micro-nutrient level in the manure. Result in table 2 showed physico-chemical properties of the cow dung used in the experimental site had the BD=1.38, AP=0.51, OC=0.58, OM=0.52, TN=0.73. Whereas exchangeable bases for cow dung used are: Ca=8.88, Na=0.92, K=23, CEC=5.3. Result showed for physico-chemical properties of poultry dropping used for the experimental site had: BD=1.20, OC=0.47, AP=0.53, OM=0.68, TN 0.74. Whereas the exchangeable bases for poultry dropping used are: Ca=7.83, Na=0.79, K=0.26, CEC=6.6. This attest to a report mentioned in Bouajila & Sanaa (2011).

Result in table 2 showed that the cow dung used for the experiment had less AP=0.51 than poultry dropping =0.53, OM=0.52 than poultry dropping =0.68, TN=0.73 than poultry dropping =0.74. The result also showed that cow dung has more of OC=0.58 than poultry dropping= 0.47, BD=1.38 than poultry dropping=1.20. The result also showed that the exchangeable bases: Ca=8.88 more than poultry dropping with 7.83, Na= 0.92 more than poultry dropping with 7.83, K=0.23 less than poultry dropping with 0.26, CEC=5.3 less than poultry dropping with 6.6. The finding on the experimental site soil conformed to those reported by Alhassan *et al*, (2018) on Sahelian savannah soil of Bade, Nigeria.

Effect of manure on seedlings emergence of amaranths

Table 3: Effects of manures on seedling emergence of Amaranths

Treatments	Emergence (%)
CONTROL	45.00
COW DUNGS	61.67
POULTRY DROPPINGS	63.33
L.S.D.	NS
MEAN	56.67
C.V. (%)	16.90

NS = Not Significant, C.V. = Coefficient of Variation

Result presented in table 3 indicated that poultry droppings has more effect on emergence of amaranths plant than cow dung although but show some level of effect than plot that is not treated with any soil amendments. But both are not significant on the amaranth growth and performance.

The effect of the differences in percent emergences of plants could be due to the contribution made by manure to the fertility status of the soils, as the soils were low in organic carbon content. Manure when decomposed increases both macro and micronutrients as well as enhances the physical properties of the soil. Manure is rich in organic matter, or humus, and thus improves the soil's capacity to absorb water and adsorb nutrients at exchange complexes. Poultry manure elicited higher seedling emergences than cow dung and control in decreasing order in both experimental plots (Grubben and Denton, 2004). Regardless of whether the nutrient is required in large or small quantities, if the plant does not have a sufficient supply, the growth of the plant will be limited by that nutrient. This principle is commonly referred to as "Liebig's law," which states that the level of plant growth can be greater than that allowed by the most limiting of all essential factors. That is if the nutrient supply to crops is at a rate below the crop's requirement, yields will be reduced and the long term productivity of the land will decline. However, if the nutrients are applied in excess of crop requirements and removal, they increase the risk of agronomic problems such as crop lodging (in the case of N), nutrient imbalances or toxicities, and environmental problems such as nitrate leaching to groundwater, P runoff to surface water, and release to the atmosphere (Grubben *et al*, 2004).

Effects of manure on seedling growth of amaranths

Table 4: Effect of manures on plant height of Amaranths

Treatments	Plant Height (cm)		
	At germination	20 days after emergence	40 days after emergence
CONTROL	5.00	7.00	11.07c

COW DUNGS	4.33	8.00	13.13b
POULTRY DROPPINGS	7.00	8.23	14.23a
L.S.D.	NS	NS	1.03
MEAN	5.44	7.74	12.81
C.V.(%)	17.85	12.94	3.56

NS = Not Significant, C.V. = Coefficient of Variation

The results presented in table 4 indicated that poultry droppings have an effect on the plant height at germination with 7.00, at 20 days after emergence with 8.23, and at 40 days after emergence with 14.23. The effect of cow dung was, however, portrayed with 4.33 at germination, 8.00 at 20 days after emergence, and 13.13 at 40 days after emergence. And control with 5.00 at germination, 7.00 at 20 days after emergence, and 11.07 at 40 days after emergence. Both manures have no statistically significant effect on plant height at germination and at 20 days. However, at 40 days after emergence, poultry manure (a) shows statistically significant differences over cow dung (b) and control (c).

Seedlings growth was only significantly affected by variation in manure sources at a later period of 20, and mostly 40 days after germination. This could probably be due to the fact that nutrients availability is not a major precursor for germination. Olaniyi *et al.*, (2010) mentioned temperature, aeration, and moisture as the factors needed for seed germination.

Effect of manure on the number of leaves of Amaranth

Table 5: Effect of manure on the number of leaves of Amaranth

Treatments	Number of leaves		
	At germination	20 days after emergence	40 days after emergence
CONTROL	5.00	6.00	14.00b
COW DUNGS	5.00	7.00	17.00a
POULTRY DROPPINGS	6.33	9.00	17.00a
L.S.D.	NS	NS	2.84
MEAN	5.44	7.67	16.67
C.V. (%)	12.24	11.91	10.39

NS = Not Significant, C.V. = Coefficient of Variation

Statistical analysis of number of leaves in table 5 showed a significant effect of poultry manure and cow dung over the control at 40 days after germination. Non significance effect of poultry manure and cow dung on plant number of leaves was recorded at germination with 6.33, at 20 days after emergence with 9.00 for Poultry manure. Cow dung indicates that at germination number of leaves was 5.00 and 7.00 at 20 days after germination. Control (No treatment) at germination with 5.00, at 20 days after emergences with 6.00, at 40days after emergences with 14.00.

Effect of manure on Leaf Area Index (LAI) of Amaranth

Table 6: effect of manure on leaf area index (LAI) of Amaranth

Treatments	Leaf Area Index (cm^2)		
	At Germination	20 days after Emergence	40 days after Emergence
CONTROL	1.07	2.00c	4.00c
COW DUNGS	1.13	3.09b	6.00b
POULTRY DROPPINGS	1.10	4.00a	8.60a
L.S.D.	NS	0.78	1.91
MEAN	1.10	2.03	5.67
C.V. (%)	14.58	2.86	24.96

NS = Not Significant, C.V. = Coefficient of Variation

Statistical analysis of Leaf Area Index (cm^2) showed in table 6 indicated that both poultry dropping and cow dung show significant effects on the leaf area index of amaranths at later days after germination, i.e., at 20 and 40 days after germination, respectively. No significance was recorded for both germination with 1.10 cm^2 and 1.13 cm^2 for poultry droppings and cow dung, respectively.

The positive effect of manure on plant leaf area index could be due to the contribution made by manure to the fertility status of the soil, as the soils were low in organic carbon content. When decomposed, manure increases both macro and micronutrients as well as enhances the physico-chemical properties of the soil (Abdelrazaq, 2004).

CONCLUSION

The rapidly rising cost of chemical fertilizer has forced small scale vegetative farmers to look for alternative such as used of organic manure, The experimental results of this study have shown that the application of poultry dropping has induced a relatively higher growth performance than cow dung.

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