International Conference on Sciences, Engineering & Environmental Technology (IJOSEET), 6(38): 305-310, 2021
ISSN 0794-9650
www.repcomseet.org

Effect of Organic Manure and Inorganic Fertilizers on Soil Bacterial Diversity and Growth of *Amaranthus cruetus* (African Spinash

Ajayi,O.A. PhD[a*] Siyanbola, G.A[b]. & Olufade, I.I.[c]

[a-c] Science and Laboratory Technology Department
Federal Polytechnic Ede, Osun State. Nigeria
Correspondence: oyinajayiforsuccess@gmail.com.

Abstract: The ecological imbalance caused by incessant introduction of eternal input into the agroecosystem had been a global concern. The study aimed to evaluate the effects organic manure and inorganic fertilizers on soil bacterial diversity and growth parameters of African spinach. The field experiment was laid out in a randomized complete block design with plot size 2 m by 2 m and three replicates. Poultry manure, cow dung, NPK and urea were applied at 2 weeks after planting at the rate of 20 g / hectare. Data were collected on growth parameters at 4, 5 and 5 weeks after planting. Soil samples were collected at 6 weeks after planting for bacterial analysis. The highest plant height (7.03±0.2) at 4 WAP was recorded in the regimes of plants whose soil was treated with poultry manure. Result indicated that soil treated with poultry manure has the highest number of bacterial colony, 19 X 10^{-5} which was closely followed by the untreated soil (control) 16 X 10^{-5} colonies. Biochemical characterization revealed five species of bacterial. This implies that application of organic manure could increase soil bacterial diversities as well as enhanced growth of African spinach. However, the ecological imbalance due to increased or decreased bacterial colonies may have negative consequences on other soil micro and macro fauna. Thus, application of external input into the agroecosystem should be done with special consideration of its direct and indirect effects on other populations in the agroecosystems.

Keywords: African-spinach, Cow-dung, NPK, Soil, Poultry manure, Urea.

1. Introduction

One of the most important vegetables that are widely grown and consumed grown in Nigeria is African spinach (Efo – tete). It is also widely cultivated and can be found in almost every market all over Africa (Schippers, 2000). African spinach is mostly eaten in cooked or processed form and was reported to contained protein oil, calcium, iron, magnesium and phosphorus (Omotoso and Shitu, 2007). Decline in soil nutrients is one of the major constraints of crop production in Nigeria. In the past years, inorganic fertilizer was advocated for crop production to ameliorate low inherent fertility of soils in the tropics (Adekiya and Agbede, 2009). However, high cost and scarcity of inorganic fertilizers as well as their implications in increased in soil acidity and nutrient imbalance pose a constraint to the use of inorganic fertilizers (Agbede *et al*., 2008). Consequently, nutrient imbalance and soil physical degradation are major constraints against sustainable use of inorganic fertilizers in the tropics (Ewulo *et al*., 2008, Oke *et al*., 2020).

Salamat *et al*. (2021) reported that fertilizer application resulted in decreased bacterial in oil palm plantation soil. In order to sustain soil fertility over a long period of time the use of organic manure is been advocated. This is because the nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Ewulo *et al*., 2008, Oke *et al*., 2020). Also, El-Magd *et al*. (2005) reported that manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil. However, increase or decrease in soil bacteria usually result in ecological imbalance within the agroecosystems. Thus, the study aimed to assess the effects organic manure and inorganic fertilizers on soil bacterial diversity and growth parameters of African spinach.

2.0 METHODOLOGY

2.1 Field Experimental Lay out

The field experiment was conducted in an experimental farm located at the North campus of the Federal Polytechnic, Ede, (latitude 7^{o} 43'08'' N; longitude 4^{0} 29' 45'' E; altitude 230 m above the sea level), Osun State, in the rainforest agroecozone of Nigeria. The land was cleared and prepared using cutlass, hoe, rakes and shovels. The experimental field was laid out in randomized complete block design (RCBD) with three replications and a net plot size of 2 m × 2 m. There were five treatments shown in Table 1.
The land was cleared and prepared using cutlass, hoe, rakes and shovels.

Table 1: Experimental Lay-out

A	**C**		**CD**		**PD**		**NPK**		**UREA**
B	**UREA**		**NPK**		**C**		**PD**		**CD**
C	**CD**		**PD**		**NPK**		**UREA**		**C**

Key: A-C=Replicates, C=control, PD= Poultry droppings, CD= Cow dung

2.2 Planting of African spinach

The spinach seeds were planted in each plot and labeled as shown in Figure1. Two commonly used organic manure (cow dung and poultry manure) and two commonly used inorganic fertilizers (NPK and urea) were applied at 2 weeks after planting (WAP) while the control plots were left untreated.

2.3 Evaluation of the effects of organic manure and inorganic fertilizer on growth of African spinach

The effects of organic manure and inorganic fertilizers on growth of African spinach was evaluated by collecting data on plant height, root length, root width, stem girth and leaves per plant at 4, 5 and 6 WAP.

2.4 Bacterial Analysis

1 g of the soil samples was collected from each of the treated and the control. Serial dilution was carried out in 5 dilution folds while the 10^{-5} fold was used in order to reduce the microbial load. Pour plate method was used. 1 ml of the diluted sample was released into a sterile plate and sterilized Molten Nutrient Agar was poured. The plate was allowed to set, inverted and incubated at 37^{0}C for 24 hours. Cultural characteristics of the bacterial were taken with the numbers of colonies. Biochemical characterization of the bacterial was carried out in order to identify the main bacteria present in the soil.

2..5 Statistical Analysis

The data obtained from the experiments were subjected to one-way Analysis of Variance (ANOVA) while the mean differences were compared using pairwise comparison and Duncan's New Multiple Range Test (DMRT) at 5 % level of probability.

3.0 RESULT AND DISCUSSION

The result of the effect of organic manure and inorganic fertilizers on growth of African spinach at 4, 5 and 6 WAP is presented in Table 2.

TABLE 2: Effects of organic manure and inorganic fertilizers on growth of African spinach

	4TH WAP			**5TH WAP**			**6TH WAP**		
Treatments	**PH**	**RL**	**L/P**	**PH**	**RL**	**L/P**	**PH**	**RL**	**L/P**
Cow dung	**5.73**±0.3	**1.47**±0.01	**6.6**±1.2	**7.5**±0.2	**1.59**±0.02	**10.6**±1.6	**7.8**±0.5	**1.62**±0.25	**11.62**±1.3
Urea	**6.40**±0.7	**1.22**±0.03	**7.3**±1.4	**8.5**±0.3	**1.39**±0.01	**12.8**±1.5	**9.2**±0.5	**1.51**±0.01	**13.5**±1.7
NPK	**6.42**±0.6	**1.20**±0.15	**7.2**±0.9	**8.3**±0.3	**1.35**±0.04	**12.6**±1.7	**9.1**±0.7	**1.45**±0.04	**13.8**±1.9
Poultry droppings	**7.50**±0.2	**1.54**±0.05	**12.5**±2.4	**8.9**±0.2	**1.67**±0.02	**15.6**±2.0	**9.9**±0.3	**1.69**±0.07	**16.6**±2.0
Control	**4.78**±0.4	**0.97**±0.02	**5.4**±1.1	**5.6**±1.2	**1.05**±0.01	**8.1`**±1.4	**6.2**±0.4	**1.12**±0.05	**8.6**±1.6

Key: PH= Plant height, RL= Root length, L/P= Leaves per plant, WAP= Weeks after planting

The highest plant height at 4 WAP (**7.**50±0.2 cm) was recorded from the regimes of plants which soil was treated with poultry manure, this was significantly higher (p = 0.01) than plant height recorded from the entire experimental groups. This was followed by (6.40±0.7 cm) which was recorded in the regimes of plants which soil was treated with urea, however this was not significantly different (p= 0.06) from the plant heights recorded in the regimes of plants which soil was treated with NPK. The same trend was obtained at 5 and 6 WAP respectively. The least plant height (4.78±0.4 cm) was recorded from the regime of plants from untreated soil (control). This was significantly lower than the plant height recorded in the entire experimental groups.

Similarly, the highest leaf per plant (12.5±2.4 cm) was recorded from the regimes of plants which soil was treated with poultry manure at 4 WAP. This was significantly higher than the leaves per plant recorded in the entire experimental group. The same trend was recorded at 5 and 6 WAP respectively.

The cultural characteristic of the bacterial isolate is presented in Table 3.

TABLE 3: Cultural Characteristic of Bacterial Isolated from Soil Samples

	Cow dung	**Poultry manure**	**NPK**	**UREA**	**Control**
Degree of growth	Scanty	Scanty	Scanty	Scanty	Scanty
Surface	Smooth	Smooth	Smooth	Rough	Rough
Elevation	Umbonate	Convex	Raised	Raised	Convex
Edge	Entire	Entire	Entire	Entire	Entire
Opacity	Opaque	Transparent	Opaque	Transparent	Transparent
Color of colony	Pink	Yellow	Brown	White	Cream

Average bacterial count of soil treated with organic and inorganic manure is presented in Figure 1. The highest bacterial count (19×10^{-5} cfu/g) was recorded in the soil treated with poultry manure, this was followed by the bacterial count from the untreated soil (control). The least bacterial count (6×10^{-5} cfu/g) was recorded from the soil treated with urea.

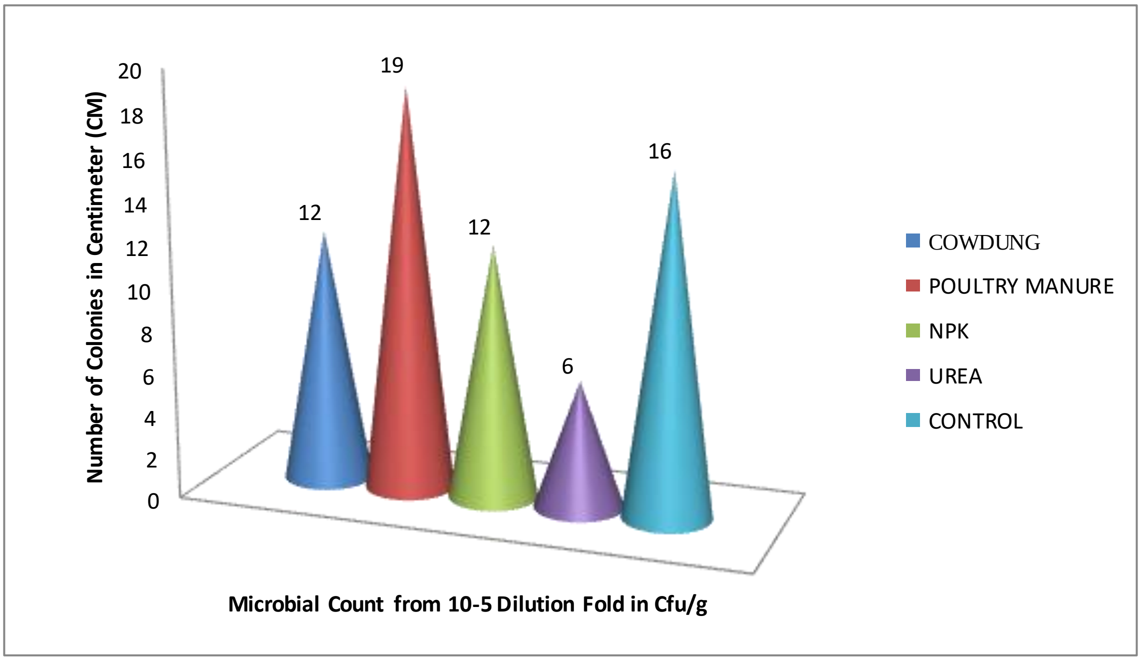

Figure 1: Average Numbers of colony forming unit (CFU/g) from Isolated Samples

Table 4 shows the biochemical characteristics of the bacteria and the suspected bacteria.
The suspected bacteria from poultry dropping treated soil is *Pseudomonas aeruginosa,* while *Serratia marcescens* was suspected from NPK treated soil.

Table 4: Biochemical Result of Isolated Bacteria from the *African spinach* Soil Samples

Isolates Codes	Gram Staining	Catalase	Oxidase	Methyl Red Test	Vogas Proskaeur	Indole	Citrate Utilization	Urease	Nitrate Reduction	Motility	Gelatin Hydrolysis	Coagulase	SUSPECTED ORGANISM
PD	- ve	+ve	+ve	- ve	- ve	- ve	+ve	- ve	+ve	+ve	+ve	- ve	*Pseudomonas aeruginosa*
NPK	- ve	+ve	- ve	- ve	+ve	- ve	+ve	+ve	- ve	+ve	+ve	- ve	*Serratia marcescens*
UR	+ve	- ve	- ve	- ve	- ve	- ve	- ve	- ve	+ve	- ve	+ve	- ve	*Clostridium difficile*
CW	+ve	+ve	+ve	- ve	+ve	- ve	+ve	- ve	- ve	+ve	- ve	- ve	*Bacillus aereus*
C	+ve	+ve	+ve	- ve	- ve	- ve	- ve	+ve	- ve	- ve	- ve	- ve	*Micrococcus luteus*

KEYS: PD (Poultry droppings), UR (Urea), CW (Cow dung), C (Control), +ve (Positive), -ve (Negative)

The result of this study revealed that the organic manure precisely poultry manure significantly increased the growth of African spinach. This is in line with the findings of Abou El-Magd (2005) who reported that organic manure could provide a source of all necessary macro and micro nutrients in available forms for the plants. However, in the study, cow dung was not as effective as poultry droppings. This might be due to the components of their feeds.
It was observed that application of poultry droppings led to increased soil bacteria count, this corroborated the findings of Salmat *et al*. (2021). Also, the bacterial count was significantly lower with the application of inorganic fertilizers. This supported the findings of Salamat *et al*. (2021) who discovered that fertilizer application led to decreased bacterial in oil palm plantation. The soil bacterial abundance and diversity might be a contributing factor to growth and developments of plants.

The result of the biochemical characterization revealed *Pseudomonas aeruginosa* from the soil treated with poultry droppings, *Serratia marcescens* from the plots treated with NPK fertilizer, *Clostridium difficile* from the soil treated with urea while *Bacillus aereus* and *Micrococcus luteus* were suspected from the soil treated with cow dung and the untreated (control) respectively.

4. Conclusion and Recommendation

The ecological imbalance that may result from increased or decreased bacterial colonies might have negative consequences on other soil micro and macro fauna. Thus, application of external input into the agroecosystem should be reduced to the barest minimum in order to maintain ecological balance.

References

[1] Abou El-Magd, M., Hoda, M., Mohammed, A. and Fawzy, Z.F. Relationship growth, yield of broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers. *Annals of Agricultural Science*, 2005; 43 (2):791-805.

[2] Adekiya, A.O. and Agbede, T.M. Growth and yield of tomato as influenced by poultry manure and NPK fertilizer *Emirate Journal of Food and Agriculture* 2009; 21 (1): 10-20

[3] Agbede, T. M., Ojeniyi, S. O. and Adeyemo, A. J. Effect of poultry manure on soil physical and chemical properties, growth and grain yield of *Sorghum* in South West, Nigeria *American-Eurasian Journal of Sustainable Agriculture* 2008; **2**(1):72-77.

[4] Ewulo, B.S; Ojeniyi, S.O and Akanni, D.A. Effect of poultry manure on soil physical and chemical properties, growth, yield and nutrient status of tomatoes *African Journal of Agricultural Research*.2008; **3**(9): 612- 616

[5] Oke, O.S., Jatto, K.A., Oyaniyi, T., Adara, C.T., Marizu, J.T., Ogunbela, A.A and Adebayo, G.J. Responses of different poultry manure level to the growth and yield of cucumber in Ibadan, Nigeria. *Journal of Forestry, Wildlife and Environment* 2020; 12(3): 206-215.

[6] Omotoso, S.O. and Shitu, O.S. Effect of NPK fertilizer rates and method of application on growth and yield of okra at Ado Ekiti Southwestern, Nigeria. *International Journal of Agricultural Research* 2007;2 (7): 614- 619.

[7] Salamat, S.S., Hassan, M.A., Shirai,Y., Mohd, Zainudin, M.H., Mustapha, N.A., Mat, M.N., and Abubakar, M.F. Effect of inorganic fertilizer on soil microbial diversity in an oil palm plantation. *Bioresources* 2021; 16(2):2279-2302

[8] Schippers, R.R. African Indigenous Vegetables: An Overview of the Species. National Resources Institute ACP-BU Technical Centre for Agriculture and Rural Cooperation, Cathan: UK, 2000, p. 15