Soil Chemical Properties, Growth Parameters and Yield as Affected by Poultry Manure Tea for Okra Production

A. O. Ojo¹, A. O. Sokalu² and A. K. Faramade³

¹Institute of Agricultural Research and Training, Moor Plantation, Apata, Ibadan, Nigeria.
²National Institute of Horticultural Research and Training, Idi-Ishin, Ibadan, Nigeria.
³Federal College of Agriculture, Moor Plantation, Apata, Ibadan Nigeria.

Authors’ contributions

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

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ABSTRACT

A study was conducted in the experimental farm of the Federal College of Agriculture, Ibadan, Nigeria to determine the effect of poultry manure tea on soil chemical properties, the vegetative growth and yield of okra. The experimental design was a randomized complete block design (RCBD) replicated three times. The treatments consists of 2kg of poultry manure soaked in 50, 75, 100 liters of water and N.P.K 20-10-10 while okra was used as the test crop. The results showed that the application of 2kg of poultry manure in 100 liters of water increased the soil chemical properties significantly while the application of 2kg of poultry manure in 75 liters of water was observed to support more of the vegetative growth of okra as well as the yield of the okra plant. Although, N.P.K 20-10-10 inorganic fertilizer increased the parameters measured, poultry manure tea was significantly better.
Keywords: Chemical properties; okra; poultry manure; vegetative growth.

1. INTRODUCTION

Okra (Abelmoschus esculentus L.) is an annual crop grown mainly as fruits and leafy vegetables in both green and dried state in the tropics [1]. The fresh fruit is a good source of vitamins, minerals and plant protein [2]. Okra is cultivated under rainfed and in irrigated areas on a wide range of soils. Soils in the tropics have been reported to be low in nutrients [3]. Nitrogen is an important and commonly deficient nutrient element in tropical soils and it is the primary element of concern in vegetable production. In order to ameliorate nutrient depleted soils, inorganic fertilizer has been used by researchers and farmers [4]. The use of inorganic fertilizer has not been helpful under intensive agriculture because it is often associated with reduced crop yield, soil acidity and nutrients imbalance [5]. Farmers cannot also depend on inorganic fertilizer input because of the unavailability of the right type of inorganic fertilizers at the right time, high cost and lack of access to credit [6]. Improvement of environmental conditions and public health are important reasons for advocating increased use of organic materials and moreover, okra cultivation can be supported with organic manures [7]. Poultry manure has been reported to contain a relatively high nitrogen content that supports more of vegetative growth of crops [8] and recently, the application of poultry manure at 5 and 10 t ha\(^{-1}\) has been reported to increase soil pH, organic matter, N, Ca, Mg and CEC significantly [9]. For centuries, farmers and gardeners have mixed and soaked plant wastes, manures and compost in water and used the rich decanted brew as a liquid fertilizer or “organic tea” [10]. An experiment [11] carried out has suggested that this certain liquid extractions of manures (herein called “organic tea”) at various stages of decay, can supply plants with at least four major benefits [12], a source of plant nutrients, a source of beneficial organic compound, an ability to suppress certain plant diseases and a way to build soil structure when applied as a drench. The nutrients from fresh manure teas tend to be soluble salts especially macro nutrient (N, P, K Ca, Mg and S) with micronutrients (e.g. Fe, Zn, Mn and Cu). Farmers have complained of the bulkiness of poultry manure and therefore a need for another alternative fertilizer. In countries like Australia, poultry tea has been on both vegetables and maize but with little efforts on such crops in Nigeria and this however led to this experiment.

The main objective of the experiment was to determine the effect of poultry tea on the growth and yield of okra and as well as determine its effect on the soil chemical properties.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was located at the experimental farm of the Federal College of Agriculture, Institute of Agricultural Research and Training (I.A.R & T), Ibadan during the rainy season of 2013 at latitude 7º22N and Longitude 3º50E. The area had an annual rainfall of 1,200mm, mean temperature of 27ºC and a relative humidity of 30-75% in the rainforest vegetation zone of Nigeria.

2.2 Methodology

The experimental site was ploughed twice and harrowed once. Composite surface soil samples were randomly collected for pre-physical and chemical properties. The total land area of 16m x 14m was mapped out for the experiment. The variety of okra seed was LD-88 and these were sown at a plant spacing of 50cm between rows and 50cm between individual plants.

The experimental design was a randomized complete block design (RCBD) with three [3] replicates. The plot size was 2m x 2m (4m\(^2\)) and the treatments consist of the control (T1), 2kg of poultry manure in 50liters of water (T2), 2kg of poultry manure in 75liters of water (T3), 2kg of poultry manure in 100liters of water (T4) and 120kg N/ha of N.P.K 20-10-10 fertilizer (T5).

2.2.1 Preparation of the poultry manure tea

Cured poultry manure of about 2 months was used for the preparation. The passive method of poultry tea preparation was used, involving bagged slurry that was simply allowed to soak in water. Using this method, 2kg of the cured poultry manure was soaked into three [3] sacks and the sacks were tied with ropes. Each of the sacks containing the cured manure was soaked into 50 liters, 75 liters, and 100 liters of water in a container. The containers were then left for 72 hours for the nutrients in the manure to leach into the water.
2.2.2 Data collection

Morphological data such as plant height, number of leaves per plant, stem girth; number of fruits per plot and weight of fruit per plot were collected on a weekly basis.

2.2.3 Statistical analysis

Chemical analysis was done on the soil after harvesting [13]. The data collected was subjected to analysis of variance and the means separated by Duncan multiple range tests [14].

3. RESULTS

The results of the pre-cropping analysis showed that the soil is slightly acidic with a pH of 6.86 while organic carbon, nitrogen was low in the soil and available phosphorus was moderately available (Table 1). Although, the exchangeable bases namely calcium, sodium and magnesium was adequate in the soil, potassium was however low in the soil. The CEC value was adequate enough for the soil and the results of the textural classification shows that the soil is a sandy loam soil.

| Parameter                  | Value |
|----------------------------|-------|
| pH in H₂O                  | 6.06  |
| Organic Carbon (g kg⁻¹)    | 12.8  |
| Total Nitrogen (%)         | 1.40  |
| Available P (mg kg⁻¹)      | 15.36 |
| Exchangeable cations (cmol kg⁻¹) |     |
| Ca                         | 1.20  |
| K                          | 0.32  |
| Na                         | 0.58  |
| Mg                         | 0.71  |
| H⁺                         | 0.06  |
| CEC (cmol kg⁻¹)            | 13.67 |
| Particle size (g kg⁻¹)     |       |
| Sand                       | 860   |
| Silt                       | 52    |
| Clay                       | 88    |

There were significant differences among the treatments for the parameters analyzed after harvesting (Table 2). The results of the post soil analysis showed that the pH of the soil was slightly increased with the exception of soil that received 120kg N of N.P.K 20-10-10. The exchangeable calcium, potassium and magnesium levels in the soil also increased while sodium increased with the exception of T1, T3 and T5. The organic carbon value also increased slightly especially when 2kg of manure in 100 liters of water was applied.

There were significant differences among the treatments across the weeks of planting. Initially, application of 120kg N of N.P.K 20-10-10 had the highest number of leaves at 4 weeks after planting (Table 3). However, the number of leaves of the okra plant continued to increase until the 7th week of planting and the most significant increase was observed with the application of 2kg of manure in 75 liters of water while the control had the lowest number of leaves.

The poultry manure tea used had significant effect on the plant height of the okra plant (Table 4). It was also observed that the height of the okra planted continued to increase across the weeks of planting. At 4 weeks after planting, application of 2kg of poultry manure in 100liters of water gave the tallest plant height but at 7 weeks after planting, application of 2kg of poultry manure in 75liters of water gave the tallest plant height while the control plot gave the shortest plant height.

A similar result to that which has been earlier observed was also obtained in (Table 5). There was a gradual increase in the width of the okra plant across the weeks of planting. Application of 2kg of poultry manure in 50liters of water had the most significant effect on the width of the okra plant at 4 weeks after planting and the width continued to increase to the 7th week. At the 7th week however, the widest width of the stem was obtained when 2kg of poultry manure in 100liters of water was applied.

There were significant differences among the treatments as a result of the application of poultry manure tea (Table 6) with the exception of T1, T3 and T5 which was not significantly different from each other. However, the application of 2kg of poultry manure in 100liters of water gave the highest number of fruits.

Application of poultry tea also increased the weight of okra as compared to the control (Table 7). This was however significant when 2kg of poultry manure was applied in 75 liters of water.
Table 2. Effect of the treatments on the soil chemical properties after harvesting

| Trt/parameters | pH  | Organic C (g kg\(^{-1}\)) | Phosphorus (mg kg\(^{-1}\)) | Calcium | Potassium | Magnesium | Sodium |
|----------------|-----|---------------------------|----------------------------|---------|-----------|-----------|--------|
| T1             | 6.17a | 1.01c | 9.73d | 1.20c | 0.52cd | 2.91d | 0.21c |
| T2             | 6.21a | 1.10b | 11.34a | 1.27b | 0.55c | 7.65a | 1.72a |
| T3             | 6.07a | 0.93d | 8.88e | 1.60a | 0.49d | 4.11c | 0.24c |
| T4             | 6.08a | 1.31a | 9.98e | 1.29b | 0.71a | 7.44b | 0.93b |
| T5             | 6.03a | 1.10b | 10.42b | 1.27b | 0.61b | 1.76e | 0.22c |

Means with the same letter are not significantly different from each other. Trt- treatments

Table 3. Effect of poultry manure tea on the leaves of okra

| Treatment | 4WAP | 5WAP | 6WAP | 7WAP |
|-----------|------|------|------|------|
| T1        | 4.45e | 6.45d | 8.02e | 10.01e |
| T2        | 4.67d | 7.54a | 9.01b | 12.57a |
| T3        | 5.23b | 6.79c | 8.79c | 10.30d |
| T4        | 4.91c | 6.79c | 8.24d | 11.34c |
| T5        | 5.55a | 7.46b | 9.79a | 12.13b |

Means with the same letter are not significantly different from each other.

Table 4. Effect of poultry manure tea on the height of okra

| Treatment | 4WAP | 5WAP | 6WAP | 7WAP |
|-----------|------|------|------|------|
| T1        | 8.30e | 10.33e | 15.00e | 23.20e |
| T2        | 9.56c | 11.78d | 15.78d | 34.10a |
| T3        | 9.81b | 13.11b | 19.11b | 28.00b |
| T4        | 11.16a | 15.32a | 23.00a | 23.70d |
| T5        | 9.29d | 12.22c | 17.11c | 27.30c |

Means with the same letter are not significantly different from each other.

Table 5. Effect of poultry manure tea on the stem girth of okra

| Treatment | 4WAP | 5WAP | 6WAP | 7WAP |
|-----------|------|------|------|------|
| T1        | 1.19e | 1.68e | 3.06e | 3.54e |
| T2        | 2.15a | 2.60a | 3.85a | 3.84d |
| T3        | 1.59c | 2.50b | 3.54b | 4.05c |
| T4        | 1.90b | 2.05d | 3.10d | 5.05a |
| T5        | 1.53d | 2.32c | 3.19c | 4.23b |

Means with the same letter are not significantly different from each other.

Table 6. Effect of poultry manure tea on the number of fruits of okra

| Treatments | Number of fruits |
|------------|-----------------|
| T1         | 10.20c          |
| T2         | 9.33c           |
| T3         | 18.19a          |
| T4         | 13.53b          |
| T5         | 10.09c          |

Means with the same letter are not significantly different from each other.

Table 7. Effect of poultry manure tea on the weight of fruits of okra (in gram per plot)

| Treatments | Weight of fruits (g) |
|------------|----------------------|
| T1         | 94.76c               |
| T2         | 107.61bc             |
| T3         | 173.23a              |
| T4         | 120.47b              |
| T5         | 102.65bc             |

Means with the same letter are not significantly different from each other; T1 –Control, T2 - 2kg of poultry manure in 50 liters of water, T3 - 2kg of poultry manure in 75 liters of water; T4 - 2kg of poultry manure in 100 liters of water, T5- N.P.K 20-10-10
4. DISCUSSION

The results of the soil analysis before planting showed that the soil was low in nutrients except some few chemical properties and therefore a need for amendment. For centuries, farmers and gardeners have mixed and soaked manures and compost in water and used the rich decanted brew as a liquid fertilizer or “organic tea” (Weltzien, 1998). However, the soil is sandy loam and the pH is slightly acidic (6.06). It has been recommended that okra production is best during long warm season in sandy loam soil with pH 5.5-7.0 and 1kg/m$^2$ of fully decomposed chicken manure should be applied [15]. The soil was significantly enriched as a result of the application of the poultry tea especially when 2kg of cured poultry manure was applied in 100 liters of water. It has been observed earlier that poultry tea was a source of plant nutrients [12]. Although little or no research work has been done on poultry tea in Nigeria, application of poultry manure at 5 and 10t ha$^{-1}$ has been observed to increase soil pH, organic matter and CEC significantly [9]. The poultry tea applied was observed to support the vegetative growth of okra. There were significant differences among the agronomic parameters measured as a result of the application of the poultry tea. The difference in heights of plants could be attributed to the availability of plants nutrients in absorbable forms and at the required time as supplied by the poultry tea applied. It has been observed that okra plant growth were greater in drip irrigation with cured poultry manure [3]. In a similar study, poultry manure has been observed to support more of vegetative growth of okra [7]. The number of fruits and its weight was also significantly increased especially when 2kg of poultry manure was applied in 75 liters of water. A study conducted on okra plants showed that irrigation water applied with chicken manure as a fertilizer gave the highest yield of okra [3]. Similar to the results observed, a research activity indicated that growth and yield of okra was lowest in control plots while the application of poultry manure positively influenced the performance and yield of okra [16]. Apart from the soil chemical properties, the vegetative growth and yield was significantly increased when 2kg of poultry manure was applied in 75 liters of water.

5. CONCLUSION

In this study poultry manure tea has been observed to enrich the soil chemical properties, increase the yield of okra as well as improve the vegetative growth of okra. Application of 2kg of poultry manure in 100 liters of water gave the most significant increase in the chemical properties of the soil while application of 2kg of poultry manure in 75 liters of water was highly effective for the yield and vegetative growth of okra. The responses observed as a result of the application of the poultry tea were all higher than what was observed for the control plot and therefore a good source of amendments for okra.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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