

Research Article

Effects of animal manures on growth and yield of maize (*Zea mays* L.)

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Abstract

A spatial survey to investigate the effects of the use of poultry, sheep, and horse manure on intermediate harvests and maize growth restrictions was conducted on the research farm of Woillu Woreda, Ethiopia during the 2017 planting season. Treatment was performed with Randomized Complete Block Design (RCBD) with three responses. The measured variables were plant length, number of leaves, location indicator (LAI), stem girth, and grain yield obtained. The data collected is subject to variance analysis (ANOVA). Methods were categorized using LSD at a 5% significance level.

The results obtained showed that the growth and yield of Maize were significantly lower in treatment control, indicating that the manure used in the study, especially the chicken manure, had a positive effect on the performance and yield of Maize. The results also revealed that poultry-cleaned sites offer the highest number of leaves per plant, the thick stem, the highest LAI, and the grain yield of 5.7 t/ha. In comparison, a small grain yield of 4.2 t/ha was obtained with the application of horse manure. Sheep manure produced 3.9 t/ha of maize and a small yield of 2.8t/ha of maize was recorded in the control management. Based on the results of the study it can be found that chicken manure seems to promote the growth of maize yield. Therefore, it should be recommended for maize growers in the study area.

Introduction

Maize (*Zea mays* L., Poaceae) is the world's most important grain after wheat and rice in terms of arable land and total production [1]. The name corn is derived from the South American Indian Arawak-Carib name mahiz. It is also known as Indian corn or maize in America [2]. This plant is a source of food for mankind and feeds animals and serves as a raw material in many manufacturing industries for the production of substances such as starch, syrup, vegetable oil, and recent uses such as biofuel [3]. The plant can grow in different agro-climate zones of the world, as they are called variable yields. No other crop has the potential for growing in as many diverse areas as maize. For example, it can grow from 580 N to 400 S, from below sea level to more than 3000m above sea level, and from low rainfall of 250 mm to 5000 mm/year [4].

The importance and use of corn vary from country to country, as many developed nations use it as fodder, but with the introduction of a new hybrid (saccharata) the crop is now used as a vegetable especially in developed countries [5]. Most African and Latin nations use it as food, and in many Asian countries, it is grown for two purposes (food and food). About a quarter of the product is consumed worldwide as food [6].

Food is one of the most important human needs. For Ethiopia to meet the demand, the need for its people, and the goal of development in food production, food including maize must be readily available. Low soil fertility may jeopardize production and food security. Soil fertility is a major barrier affecting all aspects of crop production [7]. In previous years, inorganic fertilizers were encouraged by crop production to improve soil fertility in tropical areas. In addition to the high cost of living and the lack of inputs, the use of organic fertilizers has not been good for agriculture as it is often associated with declining crop yields, soil acidity, and nutrient imbalance [8]. The need to use renewable energy sources and reduce plant fertilizer costs has revived the use of organic fertilizers worldwide [9].

The recycling of animal manure for use as an inexpensive organic fertilizer has had a positive effect on the growth and harvest of biodiversity and promoted the restoration of ecosystems and economic activities of the soil. The content of organic matter (OM) in animal manure is high and its addition to agricultural soils often improves soil structure, chemistry, and the Antonio environment [10]. Organic amendments alleviate OM which improves soil structure through nutrient uptake, water retention capacity, full perforated area,

More Information

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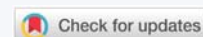
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aggregate stability, resistance to erosion, preventing of temperatures, and reducing soil compaction.

Crops such as corn need nutrients such as N, P, K, Mg, Ca, Na, and S to produce well. These nutrients are functional and must be given to the plant at the right time and in the right amount for proper growth and reproduction [11]. However, there is a renewed interest in the efficient and effective use of natural fertilizers to maintain soil fertility [12]. Apart from being a source of plant nutrients, organic fertilizers, e.g. Chicken manure and animal manure have improved agricultural productivity in African countries. Organic fertilizer helps to increase the number of micro-organisms that have a specific effect on protecting plants from germs such as nematodes, and soil-borne insects and provides plant growth hormones such as auxins [13]. Organic fertilizers also help to improve the condition of the soil and provide much-needed plant nutrients. It enhances cation exchange capacity and acts as a disruptive agent against unstable soil pH fluctuations [14]. Organic fertilizers have been found to have higher economic benefits compared to the use of inorganic fertilizers. In addition, due to the growing popularity of organic products, more information is needed compared to the growth and yield of plants that are produced naturally or using inorganic fertilizers. Therefore, the purpose of this study was to evaluate the effects of three different organic fertilizers on their growth and the yield potential of maize grown in the northeastern part of Ethiopia.

Materials and methods

Experimental site

The experiment was conducted at Research Farm of Woreilla Woreda, Northeastern part of Ethiopia during the 2017 planting season. The area lies at 39° 25' 45.9" E longitude and 10° 35' 2.7" N latitude. The agro-climatic conditions of the area are moderate with an average altitude of 2730m above sea level and the annual rainfall ranges from 766.2 to 1250 mm which is usually inadequate (short), poorly distributed, and highly variable in inter and intra seasons with temperatures ranging from 19-30 °C.

Soil analysis

Surface (0 – 15 cm) soil samples were taken over each site before the start of the experiment. The samples were bulked and air-dried for analysis. Organic matter (OM) was determined by the Walkley-Black dichromate digestion method [15] and total soil nitrogen was determined by the kjeldahl method [16]. Available P was determined by the Bray-1 method and Exchangeable K, Ca and Mg were extracted using ammonium acetate. K was determined on a flame photometer and Ca and Mg by EDTA titration. Soil pH values were obtained by using a HI9813-5 portable pH/EC/TDS/°C meter (HANNA instruments, Romania, 2002).

Field methods

An experiment was laid out in a randomized complete

block design (RCBD) with three replications to investigate the effect of different organic fertilizers on the growth and yield of maize. The experiments comprised four treatments as follows: organic Manure (Co = Control (absolute), i.e. no addition of manure or chemical fertilizer, PM = Poultry Manure, SM = Sheep Manure, HM = Horse Manure. This gives four treatments replicated three times to give 12 experimental units. The size of a plot per treatment was 4 m × 6 m. organic manures (about almost dry) were collected from farmers living in the study area. The manure, semi-decomposed, was point-applied in the planting beds 30 days before sowing maize, the test crop. The maize variety, 'Bahir Mashila', was sown three seeds per hill and thinned to two later at a spacing of 80 PM × 50 PM, giving a density of four plants/m². All the growth parameters (viz; plant height, stem girth, leaf length, leaf width, leaf area, and leaf number) were taken at 3 weeks intervals (3, 6, 9, and 12 weeks after planting) from planting to harvest.

Cultural practices

Fertilization: The types of manure used were chicken manure, sheep manure, and horse manure collected from the study farmers and applied directly to the soil at 20t/ha within 30 days from the time of sowing on the ground hillsides and evenly distributed throughout the section using a hand plow and watered immediately.

Sowing: Sowing is done by hand on one side of the ridge (east side of the ridge) and done on February 11/02/2017.

Irrigation: Irrigation was applied immediately after planting the sites; irrigation was applied twice a week.

Planting: Weeds were controlled using a plow and a hand pull. Weeds were controlled twice, three weeks after sowing and just before fertilization.

Insect control: To prevent insect invasion, the insecticide thiodan, (endosulfan C₉H₆Cl₆O₃S) is applied twice during the growing season, three weeks after sowing, and during flowering.

Character studies

The following parameters were measured during the study period.

1. Plant height (cm): Ten plants were randomly selected from the 2nd & 5th ridges of each building and the plants were marked. Plant height is measured from ten plants labeled sequentially. Plant height is measured at 3 weeks (3, 6, 9, and 12 weeks after sowing) from sowing to harvest.

2. Number of leaves per plant: This parameter is calculated by counting all the leaves of ten randomly selected plants within 3 weeks (3, 6, 9, and 12 weeks after sowing) from sowing to harvest. The average number of leaves on each plant was recorded.

3. Stem girth (cm): Measured using vernier (caliper) from

the middle of the second place of ten randomly selected plants in the 2nd & 5th ridges of each episode and mean stem girth are listed.

4. Leaf Area (cm²): Ten plants are randomly selected from the 2nd & 5th ridges and the leaf area of the fourth leaf from the top is measured according to the Stickler method [17] using the following formula: Leaf area (LA) = length × maximum × 0.75.

5. Leaf area index (LAI): Leaf area index (L.A.I), non-dimensionless quantity, leaf area (upper side only) per unit of the ground area below. It is expressed as the leaf area of m² in each lower m² area. The leaf area index is measured at intervals of 3 weeks (3, 6, 9, and 12 weeks after sowing) from sowing to harvest using the following formula:

$$LAI = \frac{Y \times N \times AL}{AP}$$

Where,

Y = number of plants per plot

N = average number of leaves

AL = the average area per leaf

AP = building location

Statistical analysis

The data collected is subject to variance analysis using STATVIEW Software. Methods were categorized using the Significant Differences (LSD) test. The correlation matrix was used to assess the relationship between plant growth and grain yield.

Result and discussions

The results of the physical and chemical analysis of the soil used before the start of the experiment are presented in Table 1. The results showed that the texture of the soil was sandy and naturally acidic. The soil used for testing consists of sand, mud, and mixed mud as well as a small number of organisms, N, P, and CEC. pH (H₂O) 5.3, Organic matter 1.78%, Carbon 1.01% Total N 1.4%, Available P 10.7 mg/Kg, K, Ca and Convertible Mg are 0.28, 7.9 and 0.45 mg/ Kg respectively and CEC 6.7 respectively. This means that the soil is not nutritious and does not produce well. Therefore, reactions to organic fertilizers can be encouraged [18].

Chemical analysis of the manure used (Table 2) showed that PM appears to contain much higher amounts of organic matter and mineral nutrients (N, P, and K) compared to other manure sources. This would probably greatly increase the availability of mineral nutrients in the soil. Other researchers have found similar results in natural soil supplementation [19,20]. It was reported that poultry manure unlike chemicals and other organic fertilizers, added organic matter to the

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

| Properties | Values |
|----------------------|------------|
| pH | 8.3 |
| Texture | Sandy loam |
| Sand (%) | 67.8 |
| Slit (%) | 26.8 |
| Clay (%) | 5.4 |
| Organic matter (%) | 1.78 |
| Carbon (%) | 1.01 |
| Total N (%) | 1.4 |
| Available P (%) | 10.7 |
| Exchangeable Cations | PMol/Kg |
| Potassium | 0.28 |
| Calcium | 7.9 |
| Magnesium | 0.45 |
| CEC | 6.7 |

Table 2: Some chemical properties of the animal manure used in the study

| Animal manure source | C/N ratio | OC (%) | OM (%) | P (%) | N (%) | K (%) | Ca (%) | Mg (%) | pH (H ₂ O) | EC (dsm ⁻¹ , 1:5) |
|----------------------|-----------|--------|--------|-------|-------|-------|--------|--------|-----------------------|------------------------------|
| SM | 17.9 | 33.1 | 55.3 | 0.9 | 2.2 | 2.4 | 3.08 | 5.1 | 6.3 | 13.1 |
| PM | 7.3 | 38.2 | 65.67 | 2.9 | 5.3 | 3.1 | 5.5 | 6.8 | 6.9 | 2.8 |
| HM | 15.01 | 35 | 57.9 | 1.7 | 3.3 | 2.9 | 4.1 | 6.4 | 6.7 | 11.3 |

SM: Sheep Manure; PM: Poultry Manure; HM: Horse Manure

soil which improved soil composition, nutrient retention, aeration, soil moisture-holding capacity, and water infiltration [21]. Some researchers claim that PM significantly increases soil moisture [22], reducing soil compaction, as well as soil compaction, which in turn increases soil moisture and water retention capacity.

It has been shown that continued use of PM in the soil of one farmer has led to the formation of P over 150-200 mg kg⁻¹ [23]. In addition, Silva and Menezes [24] suggest that composting is most effective in providing plant nutrients due to its ability to prevent N-soil degradation (in the short term) and increase P and K soil content during that time of culture. Phosphorous is a very important nutrient, after N, which reduces agricultural production, and unlike nitrogen, P does not dissolve less in water and leaks less. Therefore, PM appeared to contain higher levels of P compared to other manure treatments (i.e., SM and HM), and the concentration of P in the soil was likely to reach a higher agronomic level. Animal droppings have been found to increase root temperature to normal levels, which in turn promotes mineral uptake [25]. In addition to nutrients in manure, its effects on increasing P levels and improving soil biological health are evident [26], especially at high levels of use. Garg and Bahla reported that PM provides easier P for plants than other natural manure sources.

Generally, 90% to 100% of the K in the compost is obtained in the first year of incorporation and the availability of K in the compost is considered to be the same as in the chemical fertilizer as most of the K in the compost is in the natural state [27]. High levels of K absorption by compost-treated plants are attributed to the functions of humus and folic acid extracted from compost; in dissolving minerals containing K [28]. Potassium is known to accumulate in plant parts where

cell division and growth occur. Plants require high levels of K to further their life activities during the flowering and fertilization stages, thus the high K percentage found in the leaves of the plants planted by PM indicates high levels of physical activity and K absorption by these plants. Our results suggest that the addition of compost to the soil, especially PM at a rate of 20 t ha⁻¹, an increase in soil organisms which may promote soil moisture and improve the mineral processing process and extract more nutrients into the soil solution, thereby improving plant extraction processes.

Minerals that are slowly and gradually released from the lake into the soil solution can be extracted or dug by plant roots and used by the plant to grow and develop throughout its life cycle. In contrast, the application of chemical fertilizers has shown different effects either due to nutrient loss or premature and possibly shorter plant life. It is therefore suggested that the application of natural compost as a fertilizer can be a continuous treatment, having a positive effect on the photosynthetic efficiency of the plants grown in the compost, perhaps because it maintains a fertile soil environment and ensures greater nutrient availability (i.e., N, P, and K) to plant roots for absorption and use. It can be concluded that the use of PM at a rate of 20 t ha⁻¹ is another important means of chemical fertilizer for the growth and development of maize crops. Economic benefits can be achieved when considering PM availability, availability, and field use at a lower cost than chemical fertilizers.

Effects of organic manure on maize plant height at different ages

Table 3 shows the maize crop length in 3WAS, 6WAS, 9WAS, and 12WAS. The result shows that treatment with chicken manure provides the highest crop yields in all weeks. This was followed by horse and sheep manure while the control provided very little plant length. The table also showed that there was a significant difference ($p < 0.05$) between treatments. This is in line with the Olatunji vaccination [29] and confirms this claim when okra and tomatoes grown in chicken manure perform better than their counterparts in other compost. Fertilization growth up to plant height is due to nitrogen in the compost, which has led to a longer plant because nitrogen was found to increase the number of nodes and the length of the internodes and consequently the plant height. This is in agreement with Hassan [30] who reported that chicken manure significantly increased crop height. This is also in line with results [19] that reported that chicken manure produced longer plants. This increase in crop height can be attributed to the continued supply of nutrients in poultry manure. In addition, the development of shoot apical meristem may be a reason to gain a better height. It appeared that the use of chicken manure enhanced the functions of the apical meristem, which led to an increase in height. The optimal height of the plants improves the acquisition of solar energy, which will help maintain photosynthesis.

The increase in plant height has been very effective and

is notable for plants treated with chicken manure due to the insufficiency of N [31]. The reaction of short plants to neglected plants may be related to N-poor treatment as the plant should have relied on soil fertility which has been shown to have no N content. These findings indicate that the height of the plant is sensitive to the availability of sufficient nutrients. [32]. Plant height is an important growth factor linked to the strength of a crop yield [33].

Effects of organic manure on leaf production at different ages

Table 4 shows the average maize yield in 3WAP, 6WAP, 9WAP, and 12WAP. Statistical analysis of the data (Table 4) showed that the natural fertilizer had a significant effect on the number of leaves per plant. The maximum number of leaves per plant was recorded in the manure-treated sections while the lower number of leaves per plant was recorded in control. The very high number of leaves per plant was recorded in the area treated by the chicken manure would be to the presence of high nitrogen in the plant due to the application of poultry manure. The increase in the number of leaves per plant in the application of poultry manure due to its direct role in crop nutrition is consistent with Khalil [34] who reported that chicken manure has high nitrogen which promotes plant growth and makes nutrients available to the plant. In addition, Michael [35] reported that chicken manure was found to improve leaf quality in lettuce by providing an adequate amount of nutrients that accelerate leaf growth.

The increase in the number of leaves per plant resulting from fertilizer application will have a positive effect on plant growth and energy. This is because the leaves are the main components of photosynthesis in plants. The increase in the number of leaves was a precursor to a large number of assimilates and this allows for further transfer of grain. In addition, the high number of leaves in fertilizer-treated plants contributes to better canopy production and weed compression.

Table 3: The Effect of the Treatments on the Mean Plant Height (PM) of Maize.

| Treatments | Weeks after sowing (WAS) | | | |
|------------|--------------------------|-------|-------|-------|
| | W3 | W6 | W9 | W12 |
| Co | 31.7 | 71.33 | 82.67 | 88.67 |
| PM | 77.3 | 141 | 182 | 183 |
| SM | 60 | 110.7 | 126 | 136.7 |
| HM | 71.9 | 118 | 149 | 152 |
| LSD (0.05) | 4.9** | 6.1** | 5.2** | 4.6** |

** Significant at 5% alpha level.

Table 4: The Effect of the Treatments on the number of leaves per plant of maize.

| Treatments | Weeks after sowing (WAS) | | | |
|------------|--------------------------|-------|-------|-------|
| | W3 | W6 | W9 | W12 |
| Co | 9 | 22 | 34 | 40.5 |
| PM | 14 | 30 | 51 | 64.3 |
| SM | 10.8 | 23.2 | 40.1 | 53.7 |
| HM | 12.2 | 26.5 | 45.8 | 58 |
| LSD (0.05) | 1.3** | 2.9** | 1.7** | 1.3** |

** Significant at 5% alpha level.

Effect of organic manure on maize stem girth at different ages

The interaction among Co, PM, SM, and HM was significant ($p \leq 0.05$) at 3WAS, 6WAS, 9WAS and 12 WAS. This implies that the treatment components were interdependent for the significant enhancement of plant girth. Therefore, poultry manure that produced a thicker plant girth at the end of the growth period was the best treatment for plant girth size (Table 5). Only poultry manure-treated plants had a thicker stem compared to the other treated and untreated plants. This observation is in agreement with the previous report of Ayoola and Adeniran [9] that variation in nutrients source among treatments will result in a significant variation in stem girth per plant.

The increase in the girth was not a product of secondary thickening because the plant is a monocot. Rather, it might have stemmed out of increased mitotic cell division in the stem as well as cell enlargement which then created a big sink in the stem for photo-assimilate storage. It could be said that mitotic cell division has been enhanced by a better supply of nutrients through the application of poultry manure. When the enlarged cells were filled after cell division and enlargement, expansion of stem girth resulted. Since higher nutrient is needed for this process, low plant density became the choice for the achievement of this goal. This increase in stem girth enhanced the production of higher straw yield. It is also advantageous if the targets of the production are hay and silage. Finally, better stem girth strengthens and protects plants against lodging.

In general, the result shows that treatments with organic manures gave the highest mean stem girth of maize across the weeks as compared to the control. This agrees with the finding of Anon [36] who opined that organic manure is an excellent fertilizer material because of its high nitrogen, phosphorous, and potassium content and it is more readily available than the mineral fertilizer and its effect on the soil is stable, slow in releasing nutrition to crop and also improving the soil physical and chemical properties.

Effect of organic manure on maize leaf area index at different ages

LAI-related data are presented in Table 6. Statistical analysis has shown that natural fertilizers significantly affect the leaf area index. The highest was recorded in the dung-controlled areas while the lowest LAI was recorded in the domains treated as controls. Extremely high LAI was

Table 5: The Effect of the Treatments on the Mean stem girth of maize.

| Treatments | Weeks after sowing (WAS) | | | |
|------------|--------------------------|-------|-------|-------|
| | W3 | W6 | W9 | W12 |
| CO | 9 | 22 | 34 | 40.5 |
| PM | 14 | 30 | 51 | 64.3 |
| SM | 10.8 | 23.2 | 40.1 | 53.7 |
| HM | 12.2 | 26.5 | 45.8 | 58 |
| LSD (0.05) | 1.3** | 2.9** | 1.7** | 1.3** |

** Significant at 5% alpha level.

Table 6: The Effect of the Treatments on LAI of maize.

| Treatments | Weeks after sowing (WAS) | | | |
|------------|--------------------------|--------|--------|--------|
| | W3 | W6 | W9 | W12 |
| CO | 0.024 | 0.22 | 0.62 | 1.12 |
| PM | 0.141 | 1.3 | 2.5 | 4.6 |
| SM | 0.061 | 0.59 | 1.2 | 2 |
| HM | 0.082 | 0.72 | 1.6 | 3 |
| LSD (0.05) | 0.02** | 0.35** | 0.05** | 0.18** |

**Significant at 5% alpha level.

recorded in phases infested with chicken manure possibly due to the effective availability of nitrogen as a result of which the plant absorbs more nitrogen and larger leaves are observed. The nitrogen factor is reported to increase leaf localization by increasing leaf length and width [37] and leaf size [38]. This result is consistent with Omer & Abaro reports [39,40]. The results were also consistent with Balyeri [41] studying that chicken manure contributes to the growth, yield, and nutritional status of fragrant peppers in a container (*Capsicum annum* L., var 'Nsukka Yellow'). They concluded that chicken manure increased LAI due to the availability of sufficient nitrogen, which in turn improved plant growth. These findings are further confirmed by Mulebo [42] who obtained a large indication of leaf area by applying chicken manure.

High LAI refers to higher leaf production levels, leaf expansion, and leaf length and can indicate a limited amount of light blocking the plant. LAI of any plant is a measure of the capacity of the photosynthetic transmission system. The increase in LAI due to fertilizer application has led to the accumulation of dry weight.

Effects of organic manure on yield of maize

Grain harvesting is the interaction between different parts of the crop that are affected differently by growth conditions and crop management processes. There was a significant difference ($p < 0.05$) in grain yields within treatment (Table 7). Grain yields were increased by the order PM > HM > SM > CO by 203.5%, 150%, and 139.3% over control (CO) respectively. These findings are consistent with the findings of Boateng, et al. [19] that chicken manure significantly increased grain yield.

In general, Mohanty [43] has suggested that organic fertilizers contribute to plant growth through their beneficial effects on the body, chemicals, and biological properties of the soil which may be due to irrigating the cations with organic acids and other decay products. It may be suggested that when plant fertilizer development is greater than that of chemical

Table 7: Average grain yield of maize during the planting season.

| Treatments | Average Yield t/ha |
|------------|--------------------|
| CO | 2.8 |
| PM | 5.7 |
| SM | 3.9 |
| HM | 4.2 |
| LSD (0.05) | 0.08** |

**Significant at 5% alpha level.



fertilizers, the response was usually due to improved soil conditions that were not provided with chemical fertilizers. PM height has other sources of natural fertilizer for producing tall plants with high leaf yields, high leaf area index and grain yield may be due to good and slow release of balanced nutrients and low C/N (Table 2).

Correlation analysis

Table 8 shows the correlation, matrix among some yield attributes and grain yield evaluated under the fertilizer treatments. There was a significant positive correlation between plant height with stem girth, number of leaves, LAI, and grain yield, number of leaves with LAI and grain yield and LAI with grain yield. Correlation analysis for yield and yield components showed that grain yield had a reasonable association with most of the traits measured.

Table 8: Correlation analysis among yield attributes of maize.

| | Plant height | Stem girth | Number of leaves | Leave area Index | Grain yield |
|------------------|--------------|------------|------------------|------------------|-------------|
| Plant height | 1 | 0.981** | 0.702* | 0.873* | 0.798* |
| Stem girth | | 1 | 0.654* | 0.801** | 0.653* |
| Number of leaves | | | 1 | 0.869* | 0.774* |
| Leave area Index | | | | 1 | 0.786** |
| Grain yield | | | | | 1 |

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Conclusion

In this experiment, animal dung was found to be a pool of essential nutrients that slowly extract minerals from the lake into a soil solution that can be extracted or dug by plant roots and used by the plant for body function, growth, and development throughout its life cycle. Studies have shown that maize yields can be increased by adding animal manure to ensure food security. Different types of fertilizer in equal amounts are used to provide the same amount of nutrients to the plants. Based on the easy availability, collection, and composition of nutrients and nutrient composition, poultry manure is thus recommended for maize farmers to obtain high yields per hectare in an area with high ultisol humidity.

References

- Osagie AU, Eka OU. Nutritional Quality of Plant Foods. Post-Harvest Research Unit, University of Benin, Benin. 1998;2(1): 34 -41.
- Purseglove JW. Tropical Crops: Monocotyledons. Longman Scientific and Technical, New York. 1992; 300-305.
- Remison SU. Arable and vegetable crops of the tropics. Gift-Press Association, Benin City, Nigeria. 2005.
- Shaw RH. Climate requirement, in Sprague GF, Dudley JW (Ed), Corn and Corn 638 Improvement, 3rd ed Madism, Wisconsin, WI, 1988; 609.
- Moriss ML. Overview of the world maize economy, in Morris ML. (Ed), Maize Seed Industries in Developing Countries, Lynne Rienner, Boulder, Colorado. 1998; 13-34.
- Doebley J. Molecular evidence for gene flow among *Zea* species. J Bio Sci. 1990;40(6): 443-448.
- Mbah CN, Mbagwu JS. Effect of animal waste on physicochemical properties of a dystric leptosol and maize yield in Southeastern Nigeria. Nig J Soil Sci. 2006; 1: 290 -305.
- Ano AO, Agwu JA. Effect of animal manures on selected soil chemical properties (1). Nig J Soil Sci. 2005;15: 14-19.
- Ayoola OT, Adeniyani ON. Influence of poultry manure and NPK fertilizer on yield and yield components of crops under different cropping systems in southwest Nigeria. Afr J Biotechnol. 2006;5(15): 1386-1392.
- Antonious GF. Organic fertilizers: From basic concepts to applied outcomes. In: Larramendy ML, Soloneski S, editors. Soil Amendments for Agricultural Production. Rijeka, Croatia: Intech, 2016; 157-187.
- Adekiya AO, Ojeniyi, SO. Evaluation of tomato growth and soil properties under methods of seedling bed preparation in an Afisol in the rainforest zone of southwest, Nigeria. Soil and Tillage Research. 2002; 64: 275-279.
- Olatunji O, Oboh, VU. Growth and yield of okra and tomato as affected by pig dung and other manures issue for economic consideration in Benue State. Nig J Soil Sci. 2012;22:103-107.
- Agbede TM, Ojeniyi SO. Tillage and poultry manure effects on soil fertility and sorghum yield in southwestern Nigeria. Soil Tillage Res. 2009; 64: 209-215.
- Akanni DI Ojeniyi SO. Residual effect of goat and poultry manures on soil properties, nutrient content and yield of Amaranthus in southwestern Nigeria. Res J Agron. 2008; 2: 44-46.
- Nelson DW, Sommers LS. Total Carbon, organic carbon and organic matter. In: Page, A.L. et al (Eds.), Method of Soil Analysis Part 2. Agron. Monogr. (2nd edition), ASA and SSSA, Madison, Wsc. 1982; 539-579.
- Bremner JM, Mulvancy CS. Nitrogen-Total. In: Page, A.L et al (Eds.), Methods of soil analysis Part 2, Agron Monogr. (2nd edition) ASA and SSSA, Madison, Wsc, 1982; 403-430.
- Stickler FC, Wearden S, Pouli W. Leaf area determination in grain Sorghum. Agron. J. 1961; 53: 187-189.
- Agbogidi OM, Okonmah CU. Growth and Yield of Maize as Influenced by organic Manure type in a Niger Delta. 2012.
- Baoteng SA, Zickermann J, Kornaharens M. Effect of poultry manure on growth and yield of maize. West African. J Appl. 2006;9: 1-11.
- Islam MM, Majid NM, Karim AJM, Jahiruddin M, Islam MS, Mbah CN, Mbagwu JSC. Effect of animal waste on physicochemical properties of a dystric leptosol and maize yield in Southeastern Nigeria. Nig J Soil Sci. 2006; ISSN: 1597-4488.
- Deksissa T, Short I, Allen J. Effect of soil amendment with compost on growth and water use efficiency of Amaranth. In: Proc. of the UCoWR/ NIWR Annual Conf. Int. Water Res. Challenges for the 21st Century and Water Resources Education, Durham, NC. 2008.
- Uwah DF, Eneji AE, Eshiet UJ. Organic and mineral fertilizers effects on the performance of sweet maize (*Zea mays* L.) in southeastern rainforest zone of Nigeria. Int J Agric Sci. 2011;3(1): 54-61.
- Penn CJ, Vitale J, Fine S, Payne J, Warren JG, Zhang H, Eastman M, Herron SL. Alternative poultry litter storage for improved transportation and use as a soil amendment. J Environ Qual. 2011 Jan-Feb;40(1):233-41. doi: 10.2134/jeq2010.0266. PMID: 21488512.
- Silva TO, Menezes RSC. Organic fertilization of potato with manure and, or crotalaria iuncea. II. Availability of N, P and K in the soil along the crop cycle. Reviste. Brasileira de ciencia do solo. 2007; 31: 51-61.
- AL-Hadi SS. Some effects of the influence of soil porosity on soil water content, soil water flux and soil water use. PhD. Dissertation, the Victoria University of Manchester. 1987.
- Chang C, Summerfield TG, Entz T. Rates of soil chemical changes with eleven annual applications of cattle feedlot manure. Can J Soil Sci. 1990; 70: 673-681.



27. Motavalli PP, Kelling KA, Converse JC. First-year nutrient availability from injected dairy manure. *J Environ Qual.* 1989;1: 180-185.
28. Elssa AM, Abou-Hadid AF, Saleh MM. Increasing productivity of land irrigated by marginal quality water through use of organic manure in Egypt. 1995; 95-110.
29. Olatunji US, Ayuba A, Oboh VU. Growth and yield of okra and Tomatoes as affected by pig dung and other organic manure. *Am J Plant Physiol.* 2006;1(2):78-85.
30. Hassan EAH. Effect of poultry manure and season on the performance and HCN Content of two Forage sorghum cultivar, Ph.D. Thesis, Faculty of Agriculture, University of Khartoum, Sudan. 2002.
31. Sa-nguansak DA. Effect of nitrogen fertilizer on nitrogen assimilation and seed quality of Amaranth (*Amaranthus* spp.) and Quinoa (*Chenopodium quinoa* Wild). Dissertation for the Degree of Doctor of Agricultural Science, University of Gottingen. 2004.
32. Sharma AR, Mitra BN. Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. *J Agri Sci.* 1991; 117:313-318
33. Saeed IM, Abbasi R, Kazim M. Response of maize (*Zea mays*) to nitrogen and phosphorus fertilization under agro-climatic condition of Rawalokol, Azad Jammu and Kaslim and Kashmir, Pakistan *J Bio Sci.* 2001; 4: 949-952.
34. Khalil MI, Schmidhalter U, Gutser R. Turnover of poultry manure in some upland soils of Asia: Agricultural and Environmental Perspective. *Proc. Intl. Workshop, January 2005, Hamburg.* 275-292.
35. Michael T, Phiwokwakhe D, Wahome PK, Oseni TO. Study the Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce. *Abjna.* 2010;1(6): 1319-1324.
36. Anon N. Agriculture issue on compost controversy. *Acres U.S.A.* 2002.
37. Rogeb MM, Rassay HW, ElShazly M. Vegetative growth and dry matter accumulation. *Field crop abstracts* 43: 12, Abstract 8615. 1990.
38. Kabbashi Y, Nagatoma T. Yield of soiling maize under the influence of continuous application of farmyard manure. *Herbage Abst.* 1953; 53(5):1852-1857.
39. Omer E. Effect of farmyard manure and urea fertilization on growth and yield of teff grass (*Eragrostis Tiff. Z. ucc.*) M.Sc. Thesis. Fac. of Agric. University of Khartoum, Sudan. 1994.
40. Abaro MB. The Effect of agroforestry techniques on the growth and yield of sorghum (*Sorghum bicolor*) variety abusabien. M.Sc. Thesis. Fac. of Agric. University of Khartoum, Sudan. 1992.
41. Balyeri PK, Otitoju GT, Abu NE, Umeh, S. Poultry manure influenced growth, yield and nutritional quality of containerized aromatic pepper. *Afr J Agric Res.* 2016; 11(23): 2013-2023
42. Mulebo N, Hort TG, Paulsen GM. Physiological factors affecting maize yields under tropical and temperate conditions. *Trop. Agric. (Trin).* 1983;60: 3-10.
43. Mohanty M, Painuli DK, Misra AK, Ghosh PK. Soil quality effects of tillage and residue under rice-wheat cropping on a Vertisol in India. *Soil Tillage Res.* 2006;92(7): 243-250.