# Growth and Yield of Pepper (*Capsicum chinense* JACQ.) as Influenced by Almond (*Terminalia catappa L.)* Leaves with Cattle Manure Compost in Ibadan, Nigeria

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**Abstract.** In order to study the effects of almond leaves with cattle manure (AC) compost on growth and yield of pepper, an experiment was conducted in the screenhouse located behind the Department of Agronomy, University of Ibadan in 2020. Ratio 1:1 (w/w) Almond leaves + Cattle manure (AC) was composted using a static pile method. Effect of five treatments: AC (14, 18 and 22 t/ha), NPK 15-15-15 (200 kg/ha) and the control (without fertilizer) on the growth and yield of *Capsicum chinense* were investigated. Treatments were each mixed with 5 kg soil in pots and the experiment was arranged in a completely randomized design with four replications. Data were taken on plant height (PH) stem girth (SG), number of branches (NB), number of leaves (NL), number of fruit (NF) and fruit yield of pepper (FY). Data collected were analyzed using descriptive statistics and ANOVA at $\alpha_{0.05}$. Significant differences were observed for PH, SG, NL and NB among the treatments investigated. However, NL (46.3±1.1) recorded under AC at 14 t/ha was significantly higher than other treatments. The NF under AC at 14 t/ha (18.8±2.1) was also significantly higher than the control (10.4±0.1) and NPK (15.4±1.5) by 80.7 and 22.1% respectively. Relative to the control; NPK, AC (22 t/ha), AC (18 t/ha) and AC (14 t/ha) significantly increased FY of pepper by 15.3, 16.9, 34.6 and 53.7% respectively. Application of almond leaves with cattle manure compost at the rate of 14 t/ha proved to be most effective and therefore recommended for pepper production in Ibadan.

**Keywords:** Cattle manure, *Terminalia catappa* leaves, cattle manure, compost, NPK, Pepper

## Introduction

Livestock production has tremendously increased in Nigeria and worldwide. The wastes generated from such animals are now becoming a serious environmental concern in Ibadan. Research work conducted in Ibadan by Agboola *et al*. (1981) on the availability of organic wastes showed that the city of Ibadan alone was generating 272,950 metric tonnes of municipal garbage annually. Out of which, 4,315, 93,631 and 37,223 tonnes of cattle, sheep and goat dung respectively, were being produced annually (Ameeta & Ronak, 2017).

However, recent development shows that specialization in livestock production in Nigeria now requires a large herd to boost beef production and economic growth. Hence waste may exceed carrying capacity of local ecosystem. Therefore, result into a number of pollutions and health problems which are related to their pathogens, odours, and air borne microorganism (Zhang & Felmaan, 1997; Nayana & Ritu, 2017). These wastes when released in large quantities to the environment could constitute a serious pathogenic odour which can pollute the atmosphere and killed millions of fish in nearby rivers.

However animal manure is commonly used to grow vegetables such as pepper, *Amanranthus* and tomato especially at household levels. Therefore, animal manure such as cattle manure is cheaper and readily available and can be used as an alternative source of nutrients supplying to crops (Ameeta & Ronak, 2017). However, due to high quantity needed, adequate quantity of organic waste may not be obtained, hence farmers often apply different wastes (almond leaves and cow dung) combined. Since the wastes such as almond leaves and

cattle dung are of different compositions, their combined use as compost is expected to have positive cumulative and complementary effects on nutrient supply and yield improvement of pepper. Among the benefits of compost are: improvement of soil structure, soil porosity, Soil pH, CEC, SOM and suppression of soil borne pathogens (Composting council, 2000; Nyle & Ray, 2014).

Furthermore, previous worked had shown that soil amended with stable and mature composted materials such as biosolid municipal solid waste and yard trimmings increased growth and yield of beans, okra, water melon, tomato and pepper (Stoffella, 1995; Jimin *et al.* 2013). In a similar way, Olugbemi, and Ogunsesin (2020), revealed that application of compost increased the production of okra more than the untreated plot. However, there is limited information on the combined use of almond leaves and cattle manure as compost fertilizer in the production of pepper in Ibadan. Therefore, effect of mineralization of *Terminalia catappa* leaves with cattle manure compost on the growth and yield of pepper (*Capsicum chinense*) was investigated in the screen-house located behind the Department of Agronomy, University of Ibadan.

## Materials and Methods

### The Study Area

The experiment was carried in Ibadan which is located in the Southwest of Nigeria between latitudes $7^{\circ}$ $25^{1}$ and $7^{\circ}$ $31^{1}$ N and longitudes $3^{\circ}$ $51^{1}$ and $3^{\circ}$ $56^{1}$ E in the Rainforest Zone. The annual rainfall (1625.5 mm), daily air temperature (27.7℃ ) and relative humidity (79.9%) recorded in Ibadan, in 2020. The soil of the area is Alfisol according to the USDA classification. It is formed from Basement Complex rocks. It is classified locally as Iwo series (Smyth & Montgomery, 1962).

### Compost Preparation

A 1:1 (w/w): Almond leaves + Cattle manure (AC) was composted in 2019, under a shed located behind the Department of Agronomy, University of Ibadan using a static pile method. The mixtures (Almond leaves + Cattle manure) were turned and watered fortnightly (2.1 and 2.2). Temperature readings were taken at 50 cm depth from five spots in the compost pile at 10.00 am daily, using a glass bulb thermometer. The daily temperature was compared with the ambient temperature. The stability of the compost was taken as when the compost temperature was at equilibrium with the ambient temperature.

**Plate 1. Almond leaves + Cattle manure at initial stage of composting**

**Plate 2. Almond leaves + cattle manure compost after 62days o composting**

**Screenhouse Experiment**

The experiment was conducted in the screenhouse located behind the Department of Agronomy, University of Ibadan, between March and July, 2020. Effects of five fertilizers treatments: control (without fertilizer), AC at 14, 18 and 22 t/ha and NPK 15-15-15 at 200 kg /ha on the growth and yield of *Capsicum chinense* were investigated. Each was mixed with 5 kg soil in pots and the experiment arranged in a completely randomised design with four replications. Soils used were those collected from the experimental site at the Teaching and Research Farm along the Botanical Garden, University of Ibadan. There were two pots per treatments and 10 pots per replicates. One seedling of *Capsicum chinense* was transplanted into each pot at 4 WAS in the nursery, a week after treatments application to enhance mineralization. Watering was carried out weekly and weeding was done fortnightly during the experimental period.

**Soil Analysis**

Top soil samples (0-15 cm) used for the screenhouse experiment, were randomly collected using soil auger at the Teaching and Research Farm, University of Ibadan were air dried, crushed and passed through 2 mm wire mesh for the determination of pH, P, K, Ca, Mg and Na . The soil pH was determined on pH meter using 1:1 soil: water ratio. Phosphorus was determined by Bray P1 method and colour was developed in soil extracts using the ascorbic and acid blue method (Murphy & Riley, 1962). Exchangeable K, Ca, Mg and Na were determined by neutral ammonium acetate extraction method. Potassium and Na concentration in the extract were determined using the flame photometer; while Ca and Mg were determined by atomic absorption spectrophotometer (Okalebo *et al.*, 1993). Organic carbon and total N was determined from the soil sieved with 0.5 mm wire mesh. Soil organic carbon was determined using the Walkley-Black oxidation method (Nelson & Sommers, 1982). Total N was also determined using the Macro kjeldahl procedure (Bremner & Mulvancy, 1982). Particle size analysis was determined using Bouyoucous hydrometer method (Bouyoucous, 1962).

**Plant Analysis**

The initial materials (almond leaves and swine manure) were analysed for C, N, P, K, Ca and Mg. At maturity the compost was air-dried. Five samples were taken in the compost pile, milled and sieved with 0.5 mm wire mesh and subjected to chemical analysis. Carbon was determined by ash method using furnace. Nitrogen was determined using Micro-Kjeldahl procedure (IITA, 1975). The mixture of concentrated nitric, perchloric and sulphuric acid in a

ratio of 25:4:2 respectively were used to digest 0.5 g of each sample. Phosphorus was determined using Vanadomolybdate yellow colorimetry method (Jackson, 1962). Potassium was determined by flame photometry. Calcium and magnesium was measured with Atomic Absorption Spectrophotometer (Okalebo *et al.,* 1993).

**Data Collection**

Data were collected on Plant height, Stem girth, Number of leaves and Number of branches of pepper and were taken at 12 weeks after transplanting in the screenhouse, Plant height was taken from the ground level to the tip of the plant, using a measuring tape, stem girth was measured round the stem with a rope from the ground level and measured. Average fruits weights were determined weekly using weighing balance.

**Statistical Analysis**

The data collected were subjected to analysis of variance and the significant difference among the treatment means were separated using Duncan's Multiple Range Test (DMRT) at 0.05 level of probability.

**Results and Discussion**

As shown in Table 1, the sandy loam soil was low in major nutrients but high in Mg (Sobulo & Osiname, 1981). The soil pH was adequate for pepper production (Berke *et al*., 2001). The cattle manure used for the conduct of the experiment before composting had 115 g/kg OC, 15 g/kg N, 13 g/kg P, 8 g/kg K, 88 g/kg Ca, 16 g/kg Mg and 8, C/N. Fallen leaves of almond tree also composed of 397 g/kg, C, 4 g/kg N, 1 g/kg P, 8 g/kg K, 36 g/kg Ca, 2 g/kg, Mg and 99 C/N). The cattle manure with lower C:N ratio was richer than almond leaves in respect to N, P, Ca and Mg (Table 2). Almond leaves + Cattle manure (AC) after composting had 116 g/kg OC, 6 g/kg N, 2 g/kg P, 6 g/kg K, 9 g/kg Ca, 2 g/kg Mg and C/N 19 (Table 3). In this study the use of cattle manure with almond leaves ensured a reduction in the time taken by the composting process. Usually, mineral fertilizers especially nitrogen sources (urea) are used for this purpose. However, cow dung with its relatively higher nitrogen content could as well be used in alternative to N mineral fertilizer. Although, this might be far from what Mineral N fertilizer would have done, but it has advantages of being environmentally friendly which ensures integrated waste and agricultural management (Ameeta & Ronak, 2017). At the end of composting the C/N of the almond leaves decreased from 99 to 19 while N and P increased from 4 and 1 g/kg to 6 and 2 g/kg respectively. Thus enhanced mineralization of the compost on application to the soil. Figure 1. shows the daily temperature trends of almond leaves composted with cattle manure. The temperature reading of the compost piles was taken on daily basis to ascertain the time of stability of the compost. The pile was characterized by a marked reduction in volume and by heat generation towards the interior of the pile. The temperature rose to 55℃ maximum before decreased to ambient temperature at 29℃ *and* stabilized after 62 days of composting. This ensured that compost was safe for pepper use before its application into the soil (Olugbemi & Ogunsesin, 2020). Application of AC at 14, 18, 22 t/ha and NPK fertilizer significantly increased ($p < 0.05$) plant height, stem girth, number of leaves and branches of pepper compared with the control (Table 4). However, the highest plant height (33.4 cm), stem girth (2.0 cm) and number of branches (7.3) of pepper under AC at 22 t/ha were not significantly different ($p > 0.05$) from other AC treatments. While the maximum number of leaves (46.3) under AC at 14 t/ha was significantly higher ($p < 0.05$) than the control and NPK by 86.7 and 58.0% respectively (Table 4). Relative to the control; AC at 14, 18, 22 t/ha and NPK significantly increased number of fruits of pepper by 80.8, 71.2, 36.5 and 48.1% respectively. While same treatments increased the fruit yield by 53.7, 34.6, 16.9 and 15.3% respectively (Table 5). Heavier pepper

fruits yield were produced under the AC treatments than the NPK fertilizer. This could be that there was better partitioning of assimilates with higher concentration to fruit production coupled with the potential of compost to supply macro nutrient to the soil for pepper uptake which was lacking in the NPK fertilizer. The maximum fruit yield (68.4 g/pot) recorded under AC at 14 t/ha was significantly higher than control, 22 t/ha AC and NPK by 53.7, 31.5 and 33.3% respectively. Therefore improved availability of nutrient in the soil adduced to AC compost led to significant enhancement of growth and fruits yield of pepper. This result was corroborated by Odiete *et al.* (1999) who recorded that application of goat dung increased the yield of okra, amaranthus and maize in southwest, Nigeria. This was also affirmed by Ojeniyi and Adegboyega (2003) they noted that goat dung application led to increase growth and yield of celosia. However, the most effective treatment was AC at 14 t/ha which recorded the highest fruit production in this study. Although contradictory to 10 t/ha goat dung recommended by Awodun *et al.* (2007) for pepper production in southwest, Nigeria.

**Table 1. Physico-chemical properties of the soil of the experimental site**

| **Soil properties** | **Soil test value** |
|---|---|
| pH 1:1 ($H_2O$) | 6.1 |
| SOC (g/kg) | 7.3 |
| Total N (g/kg) | 0.9 |
| Available P (mg/kg) | 8 |
| Exchangeable cation (cmol/kg) | |
| Ca | 1.8 |
| Mg | 1.5 |
| K | 0.1 |
| Na | 0.4 |
| Effective CEC (cmol/kg) | 4.3 |
| Mechanical analysis (g/kg) | |
| Sand | 712 |
| Silt | 180 |
| Clay | 108 |
| Textural class | Sandy loam |

**Table 2. Chemical properties of raw organic material before composting (g/kg)**

| *Organic material | C | N | C:N | P | K | Ca | Mg |
|---|---|---|---|---|---|---|---|
| A | 397 | 4 | 99 | 1 | 8 | 36 | 2 |
| C | 115 | 15 | 8 | 13 | 8 | 88 | 16 |

Note: *A = Almond leaves; C = Cattle manure

**Table 3. Chemical composition of organic material after composting (g/kg)**

| *Organic material | C | N | C:N | P | K | Ca | Mg |
|---|---|---|---|---|---|---|---|
| AC | 116 | 6 | 19 | 2 | 6 | 9 | 2 |

Note: * AC = Almond leaves + Cattle manure

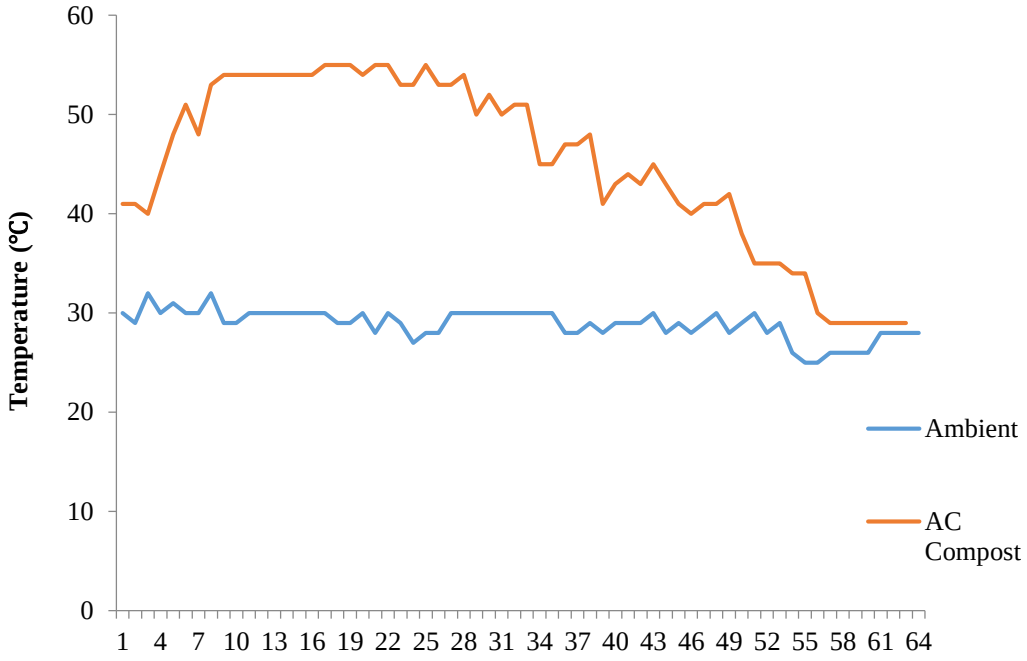


**Figure 1. Average temperature of stabilization time of almond leaves composted with cattle manure**

Note: AC - Almond leaves + Cattle manure compost

**Table 4. Effects of almond leaves with cattle manure compost on morphological trait of pepper at 12 WAT**

| Treatment* | Rate | Plant height (cm) | Number of leaves | Stem girth (cm) | Number of branches |
|---|---|---|---|---|---|
| Control | 0 t/ha | 23.8 b | 24.8 c | 1.4 c | 3.6 c |
| AC | 14 t/ha | 32.8 a | 46.3 a | 1.9 a | 7.0 a |
| | 18 t/ha | 32.3 a | 31.3 abc | 1.7 abc | 5.8 abc |
| | 22 t/ha | 33.4 a | 44.2 ab | 2.0 a | 7.3 a |
| NPK | 200kg/ha | 29.6 ab | 29.3 bc | 1.5 bc | 4.0 bc |

Note: Means in a column followed by the same letter are not significantly different by Duncan Multiple Range Test at $P < 0.05$.

* AC = Almond leaves + Cattle manure compost

**Table 5. Effects of almond leaves with cattle manure compost on yield of pepper**

| Treatment* | Rate | Number of fruits/pot | % increase in number of fruit | Fresh fruit yield (g/pot) | % increase in fruit yield |
|---|---|---|---|---|---|
| Control | 0 t/ha | 10.4 c | 0 | 44.5 c | 0 |
| AC | 14 t/ha | 18.8 a | 80.8 | 68.4 a | 53.7 |
| | 18 t/ha | 17.8 ab | 71.2 | 59.9 ab | 34.6 |
| | 22 t/ha | 14.2 b | 36.5 | 52.0 bc | 16.9 |
| NPK | 200 kg/ha | 15.4 ab | 48.1 | 51.3 bc | 15.3 |

Note: Means in a column followed by the same letter are not significantly different by Duncan Multiple Range Test at $P < 0.05$.

* AC = Almond leaves + Cattle manure compost

## Conclusions

The cattle dung which should have caused environmental pollution was composted with the *Terminalia catappa* leaves and used as organic source of nutrition to pepper in this study. The result of the findings revealed that application of almond leaves-cattle manure compost significantly enhanced growth and yield of pepper over the NPK fertilizer. However, almond leaves with cattle manure compost at the rate of 14 t/ha was the most effective and therefore recommended.

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