# Effects of Spent Mushroom Substrate and Poultry Manure on Growth and Yield of Okra (*Abelmoschus esculentus* L. (Moench) in Port Harcourt, Rivers State

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***Abstract***
*This research was carried out at the University of Port Harcourt, Faculty of Agriculture Teaching and Research Farm, Abuja campus. The effects of spent mushroom substrate and poultry droppings on the growth and yield of okra in Port – Harcourt, Rivers State were evaluated by applying these treatments (spent mushroom substrate and poultry manure) on the okra variety used (BASSANTI). The study was to determine the best organic matter that can enhance the performance of okra in terms of yield and growth in Port Harcourt, Rivers State. The research design used was Randomized Complete Block Design (RCBD).The growth parameters collected were on plant height, number of leaves and leaf area. The yield parameters collected were, date of flowering/ number of fruits, weight of fruits per plant.The result obtained from this experiment indicates that application of both organic materials positively affected the growth and yield of the okra variety used (BASSANTI) especially when compared with the control plots where no organic material was applied. Though, Poultry dropping was seen as the better organic fertilizer suitable for the growth and yield of okra, hence it is recommended to farmers in the study area for yield improvement.*

***Key words:*** *Spent mushroom; poultry manure; okra; growth; yield*

## Introduction

Okra, *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. It is grown commercially in India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus and the Southern United States. India ranks first in the world with 3.5 million tonnes (70% of the total world production) of okra produced from over 0.35 million-hectare land (FAOSTAT 2008).
It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying moisture conditions. Even within India, different names have been given in different regional languages (Chauhan, 1972).Okra is cultivated for its fibrous fruits or pods containing round, white seeds.

The okra fruit can be classified based on the shape, angular or circular (Mota *et al*., 2005). In Nigeria, cultivated Okra is of two distinct species- The Common Okra (*Abelmoschus esculentus*) and the West African Okra (*Abelmoschus caillei*) (Charrier, 1984). The common okra is adapted to the '*Sudan'* and *'Sahel'* zone in the tropics of Africa while the West

African Okra is adapted to the '*guinea*' vegetative zone. The fruits are a green capsule containing numerous white seeds when immature (Jesus *et al.*, 2008) and the flowers and upright plants give okra an ornamental value (Duzyaman, 1997). The fruits are harvested when immature and eaten as a vegetable. Okra fruit can be cooked in a variety of ways. The roots and stems of okra are used for cleaning the cane juice from which brown sugar is prepared (Chauhan, 1972).

Okra provides an important source of vitamins, calcium, potassium and other mineral matters, which are often lacking in the diet of developing countries (IBPGR, 1990). Its medicinal value has also been reported in curing ulcers and relief from haemorrhoids (Adams, 1975)
Okra is an annual crop, requiring warm external environment and found in most markets across Africa (Schippers, 2000). It is grown in the southern part of Nigeria at the peak of the raining season usually performs poorly due to pest infestation and high rainfall.
Poultry manure has long been recognized as perhaps the most desirable of natural fertilizers because of its high nitrogen content. In addition, manures supply other essential nutrients and serve as a soil amendment by adding organic matter. Organic matter in soil improves water and nutrient retention. The use of manure is an integral part of sustainable agriculture. Just like commercially prepared synthetic fertilizers, chicken manure is very high in nutrients. Poultry manure contains all 13 of the essential plant nutrients that are used by plants (Chastain *et al., 1999).*

Spent mushroom substrate (SMS) is the leftover of wastes after different flushes of mushrooms have been harvested. These growing substrates may be composed from different wastes materials such as sawdust, rice straw, bedded horse manure, cotton wastes, paper wastes, cocoa shells, wheat straw, maize husks and various other wastes (Jonathan *et al.*, 2002). After the cultivated mushroom has exhausted the nutrients within the substrates, and there are no more fruit bodies to harvest, the so-called remains, regarded, as 'the useless material' is known as spent mushroom substrate (Fasidi *et al.*, 2008). Spent mushroom substrate is believed to be a source of humus formation and humus is known to provide plants with micronutrients, which improve soil aeration, soil–water holding capacity, and contributes to maintenance of soil structure.

SMS have been reported to contain nutrients, which could be used for the growth of useful plants. These materials are generally non-toxic to cultivated plants; therefore, it could be employed as soil amendment for different crops. It has been revealed that application of SMS, which consists of degraded cellulose and lignin, is considered to be important for the improvement of soil and is safe for human consumption. In addition to providing a balanced nitrogen and carbon source for plant growth, the SMS will be further degraded in the soil humus which is very important to maintain soil structure, good aeration, water holding capacity, and also relevant to maximizing fruit crop productivity.

The increasing reliance on the use of inorganic or synthetic fertilizers especially on a long term bases in growing food crops especially okra has been found to have negative impacts and long term detrimental effects on the soil structure and excessively high expenditure stress on the farmers. This study is therefore, directed towards determining the response of the okra variety to poultry manure and spent mushroom substrate, and to determine the best organic material (poultry manure or spent mushroom substrate) that would increase the yield and growth of okra varieties

## Materials and Methods

### Experimental site

The experiment was carried out at the University of Port Harcourt, Faculty of Agriculture Teaching and Research Farm. University of Port Harcourt lies on latitude $4° 54'N$ and longitude $6° 55'E$, with an average temperature of 27℃, relative humidity of 78% and an average rainfall that ranges from 2500 – 4000mm (Nwankwo and Ehirim, 2010). A land area of 12m x 12m ($144m^2$) was marked out for the experiment. The area was marked into blocks and plots in a randomized complete block design (RCBD). Each treatment had three (3) replicates. A plot had a dimension of 2 m by 3m with a 1m walkway way between plots.

### Agronomic practices

The land was cleared, ploughed, harrowed, leveled and pegged out. Soil Samples were collected from each plot at a depth of 15cm before planting and at eight weeks after application of treatments when the plants have established before harvest. This is to know the level of nutrients added to the soil. The soil samples were analyzed for presence of Nitrogen (N), Phosphorus (P), Potassium (K), Organic matter, and soil pH.

After which the treatments were applied before planting. Each treatment was applied at the rate of 3kg /plot of $6m^2$. Seeds were sown directly at a seed rate of three seeds per hole at a planting depth of 2cm using a planting space of 60cm by 30cm between and within rows respectively. It was later thinned to two stands per hole. The seeds were sourced or gotten from Songhai Rivers Initiative Farms. BASANTI was the variety of the okra seeds planted. Weeding was done manually at intervals of four weeks after planting and two weeks subsequently.

Data collection was done at an interval of two weeks and appropriate data was collected based on the stage of crop development. The following data was collected as growth parameters: plant height, number of leaves and leaf area. The yield parameters collected were, date of flowering, number of fruits per plot, weight of fruits per plot. Data was taken randomly from 5 plants in each plot. The mean of the five was calculated and that gave the representative sample of the population. Plant height was measured in centimetre (cm) from the base of the plant to the tip of the longest leaf using a meter rule. Number of fruits was weighed after harvesting and the weights were recorded.

## Results

### Soil amendments

The results of soil analysis before application of organic fertilizer and before harvest are shown in Table 1.The pH of the soil was slightly acidic before and after application of treatments to the soil. The pH ranged from 5.90 - 6.30 for soils before amendment and ranged from 5.80-6.40 after amendments. The result reveals a lower level of nitrogen and phosphorus in the soil as against their critical levels while the potassium (K) was adequate compared to its critical level as stated by Ibedu *et al.*, (1988).

### Growth parameters

The effects of poultry manure and SMS on the plant height, number of leaves and leaf area, stem girth are represented in Tables 2-4 below.

### Plant height (cm) of okra

Table 2 showed that the plant height at 4weeks, 6 weeks, 8 weeks, and 10 weeks after planting did not show any significant difference ($P>0.05$) statistically for all three treatments.

However, from observations and the raw data collected from the plot, the highest plant height was gotten from the plot treated with spent mushroom substrate at 4 weeks – 10 weeks after planting with (20.21cm - 69.55cm), it was then followed by poultry droppings also from the 4th week to the 10th week with (18.00cm - 58.97cm) and then control which had the lowest mean or plant height with (18.00cm - 58.97cm)

**Number of leaves of okra**

Table 3 showed no significant difference in all three treatments used in this experiment to grow okra at 4 weeks, 6 weeks, 8 weeks and 10 weeks after planting. At 4 weeks after planting, observation from the table showed poultry droppings to be the highest in producing leaves with (5.87cm) and Spent Mushroom Substrate to be the lowest in producing leaves with (4.93cm). But at 6 weeks after planting, Spent Mushroom Substrate had the highest mean in the number of leaves with (8.00cm) and at 8 and 10 weeks after planting poultry droppings increased with (8.93cm and 9.82cm) and became highest in the mean on number of leaves of okra with control still the lowest through the 4th week to the 10th week.

**Leaf area of okra**

At 4 weeks, 6 weeks, 8 weeks and 10 weeks after planting, Table 4 showed no significant difference in all the treatments. Observations from the result showed that SMS had the highest mean on the leaf area with (61.00cm – 229.55cm) and control had the lowest mean with (37.04cm – 238.23cm) both at 4,6 and 8 weeks after planting. While at the 10th week after planting, poultry droppings increased at a higher rate and came out with the highest mean on leaf area with (310.25cm) followed by SMS with (300.92cm) and control was still the lowest at the 10th week with (264.37cm).

**Stem girth of okra**

In Table 5, treatments showed no significant difference at 4 weeks till 10 weeks after planting. At 4 weeks after planting poultry dropping had the highest mean on stem girth with (1.23cm), at 6 weeks after planting SMS became the highest with (2.00cm), at 8 weeks after planting poultry droppings increased and became highest with (2.23cm) and at the 10th week after planting SMS slightly increased and had the highest mean on stem girth and control was noted to be with the lowest mean on stem girth at 4, 6, 8, and 10 weeks after planting with (0.97cm – 2.33cm).

**Yield of okra**

At 9 WAP as shown in Table 6, poultry droppings had the highest yield and it was not significantly different from SMS which was the second highest but was significantly different from control which had the lowest yield. At 10 WAP there was no significant difference in all treatments and SMS had the highest yield while control had the lowest yield.

**Discussion**

From the result of the soil analysis, there was an increase in the nutrient status of the soils after the application of treatments. The Total Nitrogen (TN) ranged from 0.310 - 0.385% for soils before amendment and 0.680 - 2.186% after amendments. This was the same trend in other nutrients analysed. The low Nitrogen (N) level recorded could be as a result of continuous cropping on the experimental site, excessive rainfall leading to soil erosion, leaching of nutrients which might have led to nutrient removal from the soil. The soil was amended through the addition of organic material (poultry manure) before planting was carried out.

In Table 2, the difference in the plant heights of the okra variety planted after organic substances had been applied from 4 weeks to 10 weeks after planting. The lowest height was (18.00cm) with control at 4weeks after planting while spent mushroom had the highest at 10weeks. This higher plant height is due to the fact that it takes a longer time for organic materials to decompose and release nutrients for plant growth (Chastain *et al*., 1999) at 8 weeks, the second highest plant height was in the poultry treatment at 8 weeks (49.82 cm) and at 10 weeks (64.54 cm).

The effects of the treatments on the number of leaves are shown in Table 2. Highest number of leaves from 4 weeks and 10 weeks after planting was recorded for poultry treatment with (5.87cm and 9.82cm). This goes to support (Obi and Ebo 1995), who reported that poultry manure improves the chemical and biological properties of soil which in turn increases crop productivity and this is due to the fact that poultry manure contains phosphorus which supports the vegetative growth of plants (Mengel and Kirby, 1979), followed by SMS at 6 weeks and 8weeks and control with the least mean where no treatment was added at 4 weeks – 10 weeks after planting.

At 4 weeks, 6 weeks, 8 weeks and 10 weeks after planting, Table 3 showed no significant difference in all the treatments. Observations from the result showed that SMS had the highest mean on the leaf area with (61.00cm – 229.55cm) and control had the lowest mean with (37.04cm – 238.23cm) both at 4,6 and 8 weeks after planting. While at the $10^{th}$ week after planting, poultry droppings increased at a higher rate and came out with the highest mean on leaf area with (300.94cm) followed by SMS with (300.92cm) and control was still the lowest at the $10^{th}$ week with (264.37cm). Overall poultry droppings had the highest leaf area across all three treatments especially at $10^{th}$ week after planting which supports Hussein *et al., (*1997) where he recorded better performance, which was associated with poultry manure over other organic manures as was evident in many agronomic plants.

In Table 4, treatments showed no significant difference at 4 weeks till 10 weeks after planting. At 4 weeks after planting poultry dropping had the highest mean on stem girth with (1.23cm), at 6 weeks after planting SMS became the highest with (2.00cm), at 8 weeks after planting poultry droppings increased and became highest with (2.23cm) and at the $10^{th}$ week after planting SMS slightly increased and had the highest mean on stem girth and control was noted to be with the lowest mean on stem girth at 4, 6, 8, and 10 weeks after planting with (0.97cm – 2.33cm)

The yield components of the okra variety used was also affected by the organic materials added. The Table 5 also shows a significant effect of the treatments on the fresh weight of the okra pods with significant difference of (367.21 Kg/ha) at 9 WAP. Both poultry and SMS treatments had the highest fresh weight (614g and 579g respectively). Similar results were achieved by Ezeibekwe *et al.,* in (2009) where he had highest flowering, fruiting and fruit biomass with poultry manure.

**Conclusion**

The result obtained from this experiment indicates that application of both organic materials positively affected the growth and yield of the okra variety used (*Bassanti)* especially when compared with the control plots where no organic material was applied. This is in agreement with the observations of Dada *et al*., (2014) and Ojobor *et al*., (2014) who stipulated that application of organic materials to the soil would improve the growth and yield properties of the crops grown as well as the soils physical and chemical properties.

The best growth and yield characteristics were obtained from the plots treated with poultry droppings. This is in accordance with the findings of Orluchukwu and Adedokun (2014), who also recorded higher growth and yield in the pineapples treated with poultry manure over those treated with SMS. Budhar *et al.*, (1991) also supports this assertion through his experiment where he recorded the highest grain yield with poultry manure.

Based on the results of the experiment, it is recommended that poultry manure be adopted as a favorable organic material for growing okra. Farmers should be encouraged to incorporate the use of organic materials especially poultry droppings in growing their crops as it provides a cheaper source of plant required nutrients.

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**Table 1: Chemical properties of the soil before and after application of treatments**

| Treatments | pH | TN | TOC | TOM | Avail.PK |
|---|---|---|---|---|---|
| | ⟶ | | | % ⟵ | mg/kg | cmolkg$^{-1}$ |
| **(Before soil amendment)** | | | | | | |
| Poultry dropping | 6.30 | 0.310 | 1.77 | 3.05 | 45.02 | 0.80 |
| Spent Mushroom Substrate | 6.10 | 0.348 | 1.60 | 2.76 | 36.48 | 1.19 |
| Control | 5.90 | 0.385 | 1.00 | 1.72 | 40.68 | 0.76 |
| **(After soil amendment)** | | | | | | |
| Poultry droppings | 6.40 | 2.186 | 3.26 | 5.62 | 85.02 | 1.29 |
| Spent Mushroom Substrate | 5.80 | 2.100 | 3.19 | 5.50 | 89.35 | 1.34 |
| Control | 6.20 | 0.680 | 1.33 | 2.29 | 58.35 | 1.08 |

**Table 2: Effect of treatments on the Plant height (Cm) of okra**

| Treatment | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|
| Control | 18.00 | 30.87 | 44.13 | 58.97 |
| Poultry droppings | 18.84 | 36.55 | 49.82 | 64.54 |
| Spent mushroom substrate | 20.21 | 37.48 | 52.30 | 69.55 |
| LSD (0.05) | 3.97$^{NS}$ | 25.39$^{NS}$ | 39.89$^{NS}$ | 50.26$^{NS}$ |

**Table 3: Effect of treatments on the number of leaves of okra**

| Treatment | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|
| Control | 5.07 | 7.27 | 8.40 | 9.40 |
| Poultry droppings | 5.87 | 7.93 | 8.93 | 9.82 |
| Spent mushroom substrate | 4.93 | 8.00 | 8.85 | 9.48 |
| LSD (0.05) | 1.37$^{NS}$ | 4.77$^{NS}$ | 4.91$^{NS}$ | 6.67$^{NS}$ |

**Table 4: Effect of treatments on the leaf area (cm) of okra**

| Treatment | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|
| Control | 37.04 | 67.01 | 238.23 | 264.37 |
| Poultry droppings | 45.05 | 82.31 | 221.75 | 310.25 |
| Spent mushroom substrate | 61.00 | 101.31 | 229.55 | 300.92 |
| LSD (0.05) | $29.55^{NS}$ | $57.22^{NS}$ | $179^{NS}$ | $212.66^{NS}$ |

**Table 5: Effect of treatments on stem girth of okra**

| Treatment | 4WAP | 6WAP | 8WAP | 10WAP |
|---|---|---|---|---|
| Control | 0.97 | 1.52 | 1.95 | 2.33 |
| Poultry droppings | 1.23 | 1.84 | 2.23 | 2.56 |
| Spent mushroom substrate | 1.09 | 2.00 | 2.21 | 2.70 |
| LSD (0.05) | $0.33^{NS}$ | $1.29^{NS}$ | $1.31^{NS}$ | $1.38^{NS}$ |

**Table 6: Effect of treatment on mean yield (kg/ha) of okra**

| Treatment | 9WAP | 10WAP |
|---|---|---|
| Control | 162.22 | 18.33 |
| Poultry droppings | 599.44 | 281.67 |
| Spent mushroom substrate | 489.44 | 292.22 |
| LSD (0.05) | 367.21 | 351.01 |