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Comparative Study on the Effects of Spent Mushroom Substrate, Cow Dung and Urea on the Growth and Development of Maize (*Zea Mays L.)*

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A B S T R A C T

This research was carried out at the Green House, Center for Ecological Studies, Abuja Campus, University of Port Harcourt, to investigate the effect of cow dung, spent mushroom substrate and urea on the growth and development of maize. The experiment was laid out on a Completely Randomized Design (CRD) using four treatments (Cow dung, Spent Mushroom Substrate, Urea and Control) with three replications. A total of 12 buckets with 7kg soil, Oba 98 maize seeds, organic fertilizer (spent mushroom substrate and cow dung) and inorganic fertilizer (urea) were used to carry out this experiment successfully. Cow dung and spent mushroom substrate were applied at the rate of 100g per bucket, while urea was applied at the rate of 4g per bucket. The growth parameters analyzed were on plant height, stem girth, number of leaves, leaf width, leaf length, leaf area, fresh shoot and root weight, dry shoot and root weight and the results obtained revealed that cow dung had more effect in all the parameters studied. For the spent mushroom substrate and urea, there were significant (P= 0.05) differences especially at week 8 on parameters like plant height, number of leaves, leaf length, leaf width and stem girth as spent mushroom substrate had higher values than urea in these parameters. However, for leaf area, fresh shoot and root weight, dry shoot and root weight, there were a high significant (P= 0.05) difference between urea and spent mushroom substrate as urea had higher values than its counterpart. Hence, based on this research, cow dung is recorded as the best fertilizer for the growth and development of maize hence; it is recommended to be used in maize production.

Keywords: Growth, development, substrate, fertilizer, cow dung, maize

1. INTRODUCTION

Maize (*Zea mays)* is one of the most relevant staple foods in the world (Liu *et al.,* 2021). It belongs to the family - gramineae and is usually found in Nigeria. This crop is known to be an essential source of energy for food security in poorly developed countries (Tanumihardjo *et al.,* 2020). The yield, nutritional value, reproductive growth of a crop plant solely relies on how fertile a soil is. To the farmers who engage in raising crops, getting a high level of productivity from the soil is a major challenge. Areas with various soil fertility rates determines the level of soil improvement, soil productivity and fertilizer application methods to be used (Lu *et al.,* 2016). Fertilizer is any material of natural or synthetic origin that is applied to soil or plant tissues to supply nutrients. It enhances the natural fertility of the soil or replace chemical elements taken from the soil by previous crops. According to Satyanarayana *et al.* (2002), research has shown that in order to get good crop yields there should be usage of mineral fertilizer and inorganic fertilizer. In this work, there is usage of organic fertilizer (cow dung and spent mushroom substrate) and inorganic fertilizer (urea) to enhance the growth and development of maize (*Zea mays* L.). In as much as there is life existence, food must be available for the sake of sustainability. Organic and inorganic fertilizer contains elements which supplies plants the nutrients needed for optimal growth and development (Jaja and Barber, 2017). Spent mushroom substrate is often regarded as waste as it is a by-product in mushroom producing companies. It is often regarded as biomass because of its high organic constituent especially lignocelluloses (Garrido *et al.*, 2005). It is often used in agriculture and can increase the organic content of the soil as well as improve its physicochemical characteristics (Becher *et al.*, 2021). Also, it brings about soil diversity since it's rich in microbiota and promote plant growth (Li *et al.*, 2020). Studies have shown that spent mushroom substrate can be a good alternative for fertilizing several crops including maize (Kwiatkowski and Harasim, 2021). A well-known fact is that cereal crops are heavy feeders and need enough nutrients to increase its yield. Among which is Nitrogen because of its function in development and growth of maize crop (Jat *et al*., 2013). According to Adekiya *et al.* (2016), it was deduced that the application of cow dung increases moisture content and maize yield. Also, Eleduma *et al.* (2020) in their study concluded that cow dung improved the growth of maize and soil fertility.

Maize (*Zea mays)* has high nutritional requirements for basic macronutrients like nitrogen, phosphorus and potassium (Liu *et al.,* 2019) and in as much as this crop is important in many countries including Nigeria, most times there is poor yield because of soil infertility which is one of the greatest challenges facing agriculture in less developed countries (Maja *et al.*, 2021). Therefore, fertilizers are needed to help supply the different nutrients which the plant will need for effective growth. They can be inorganic or organic and it should be noted that all fertilizer gives different concentration of element needed for plant growth and development. This study was aimed at investigating which fertilizer among organic (spent mushroom substrate, cow dung) and inorganic (urea) will be more effective on the growth and yield of maize *Zea mays*).

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at the Green House, Center for Ecological Studies, Abuja Campus, University of Port Harcourt, during the period of August to October, 2023. University of Port Harcourt lies on latitude 4°54"N and longitude of 6°55"E, with an average temperature of 27°C, lies on latitude 4º53'14" N through 4º54' 42" N and longitude 6º54' 00" E through 6º55' 50" E (Chima and Ofodile, 2015) and it has an average rainfall of 2500-4000mm with relative humidity of 78% (Ehirim and Nwankwo, 2010). Soil samples were collected and analyzed for presence of Nitrogen, Phosphorus, Potassium, Organic matter, soil pH, moisture content and soil particle size.

2.2 Source of Materials

The seed of *Zea mays* hybrid variety (Oba 98) was sourced from Agricultural Development Program (ADP), Port Harcourt, Rivers State. The fertilizers (Urea, Poultry Manure and Spent mushroom substrate) used were sourced from the Faculty of Agriculture Teaching and Demonstration Farm, University of Port Harcourt.

2.3 Materials Used

- 12 pieces of 7litres buckets
- 7kg of loam soil per bucket
- Oba 98 maize seeds
- Urea, spent mushroom substrate and cow dung

2.4 Experimental Design

The experiment was laid out in Completely Randomized Design (CRD) of four (4) treatments with three (3) replicates.

The 4 treatments used in this experiment are listed below:

1. Treatment 1: Urea 4g
2. Treatment 2: Cow dung 100g
3. Treatment 3: Spent mushroom substrate 100g
4. Treatment 4: No fertilizer (control)

2.5 Viability Test

A viability test was carried out using 20 seeds of *Zea mays* to ensure the seeds were viable after which 70% germination percentage was observed indicating the viability of the seeds.

2.6 Sowing, treatment and data collection.

Twelve (12) buckets were filled with 7kg of soil and perforated to ensure proper aeration and drainage. 7 maize seeds were sown in each bucket at a depth of 1.5cm thereafter, they were thinned to 2 seedlings per bucket after 7 days. Fourteen (14) days after planting, the treatments applied were: cow dung and spent mushroom substrate while the urea were applied after twenty-one (21) days using ring method of application. The plants were allowed to grow for 8 weeks with measurements of the basic parameters taken weekly after the 2 weeks. The growth parameters investigated were plant height, stem girth, number of leaves, leaf length and leaf width. Fresh weight and dry weight were determined 8 weeks after planting.

2.7 Statistical Analysis

Data collected for each of the parameters were subjected to one-way Analysis of Variance (One-way ANOVA) using Microsoft Excel at $P \leq 0.05$ probability level.

3. RESULTS AND DISCUSSION

3.1 Soil Analysis

The results are presented in Table 1

Table 3.1 Physiochemical (physical and chemical) properties of the soil

Soil Properties	Values
pH	6.1
Moisture content (%)	12.74
Total organic carbon (%)	6.32
Total organic matter (%)	10.99
Exchangeable Bases	
Nitrogen	0.0604
Phosphorus	19.260
Potassium	0.130
Sand (%)	96.63
Clay (%)	0.24
Silt (%)	2.83
Textural Class	**Sandy Clay Loam**

The plant height in cm is presented in fig. 1 and it varies significantly at P = 0.05 with the application of spent mushroom substrate, cow dung and urea. At 8 weeks, the highest Plant height was seen in Cow dung (76.2cm) followed by Spent mushroom substrate (55.7cm), urea (36cm) and the least was seen in control (27.8cm).

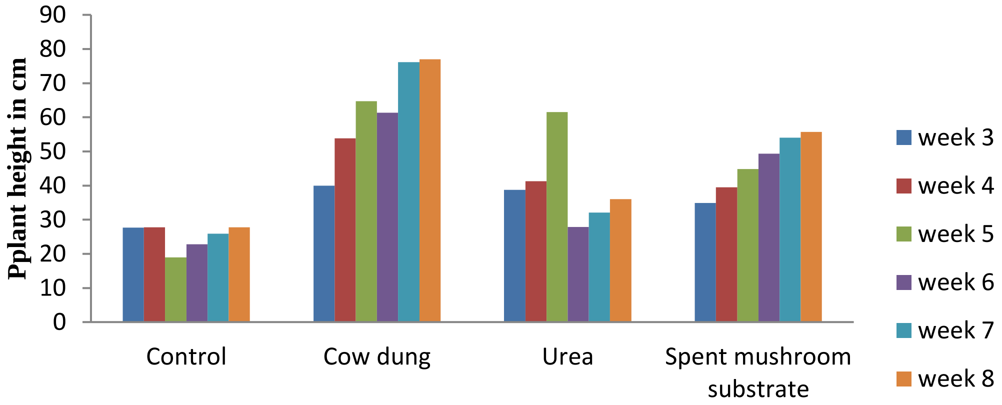

Figure 1: Effects of Cow dung, Urea and Spent mushroom subtrate on Mean Plant Height

The Number of leaves is presented in fig. 2 and it varies significantly at P = 0.05 with the application of spent mushroom substrate, cow dung and urea. At 8 weeks, the highest number of leaves was seen in Cow dung (7.3) followed by Spent mushroom substrate (5), Urea (3.1) and the least number was found in control (3).

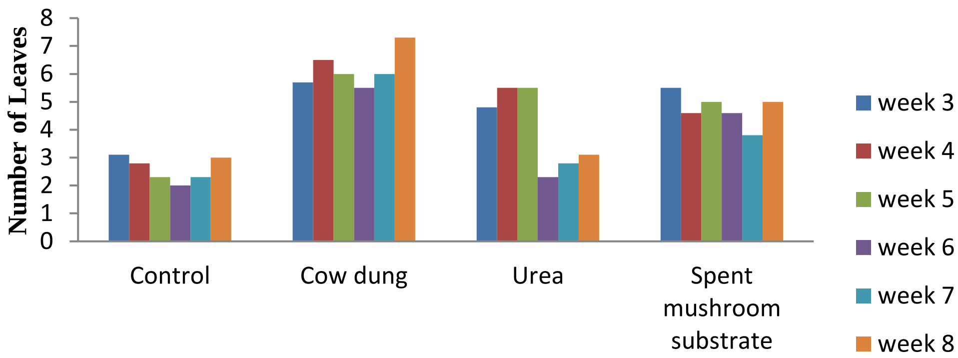

Figure 2. Effects of Cow dung, Urea and Spent mushroom subtrate on Mean Number of Leaves

The leaf length of the plant in cm is presented in fig. 3. and it varies significantly at P = 0.05 with the application of spent mushroom substrate, cow dung and urea. At 8 weeks, the highest leaf length was seen in Cow dung (55.7cm) followed by Spent mushroom substrate (38.5cm), Urea (26.8cm) and the least was seen in Control (20.7cm).

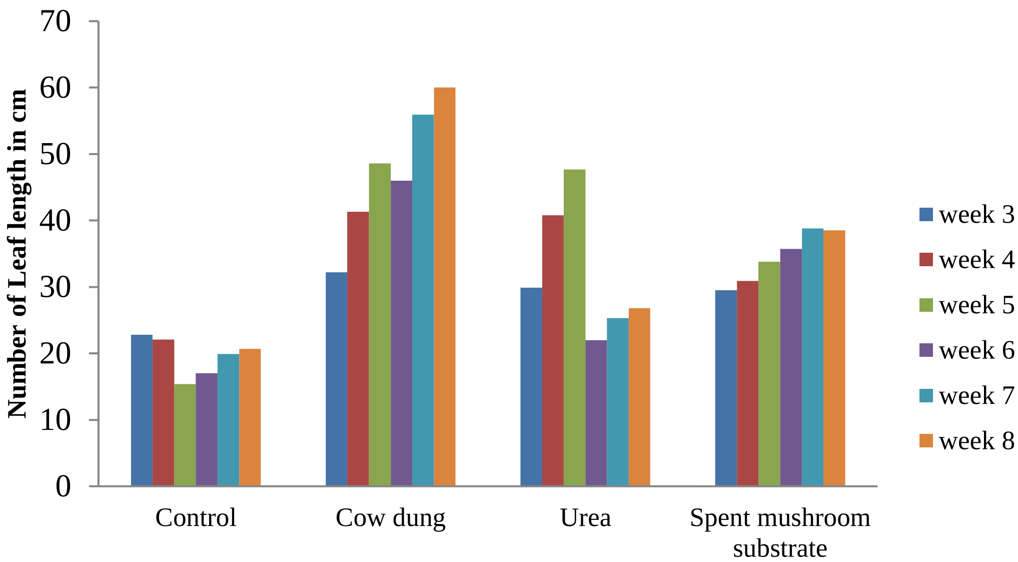

Figure 3: Effects of Cow dung, Urea and Spent mushroom subtrate on Mean Leaf length

The fresh weight of the plant in grams fig. 4. varied significantly at P = 0.05 with the application of spent mushroom substrate, cow dung and urea. The highest fresh weight of the shoot was seen in Cow dung (58.7g) followed by Urea (40.2g), Spent mushroom substrate (25.9g) and the least seen in control (6g) while in Root The highest fresh weight of the Root was seen in Cow dung (45.9g) followed by Urea (30g), Spent mushroom substrate (17.7g) and the least seen in control (3.5g).

The growth and development stages of the maize plant improved greatly with the application of spent mushroom substrate, cow dung and urea. The increase in its growth and development could as well be attributed to the environmental factors such as temperature, soil moisture, solar radiation, rainfall and many others. Temperature is one of the three primary environmental factors influencing plant phenology and physiology alongside solar radiation and soil moisture (Walne and Reddy, 2022). It is also important to note that the distribution of rainfall during critical phenological stages is also important for maize (Omoyo *et al.*, 2015).

The results from the study showed that the parameters studied varied significantly at P = 0.05 by the application of cow dung, spent mushroom substrate and urea. it was observed that the application of cow dung attained the highest values in plant height, number of leaves, leaf length, fresh weight of shoot and root Although the values varied from week to week more like a rise and fall in between the weeks (which may be as a result of trying to adapt to the environmental factors), it generally had the highest values amongst other treatments at week 8. This is in line with the results of Li *et al*. (2022) that the application of cow dung significantly promoted maize growth by increase of plant height, stem diameter, fresh weight of shoot and fresh weight of root, increased soil organic matter (SOM) content and soil fertility. The effectiveness of this fertilizer will be ascribed to its high organic contents due to the presence of compost in it (Oo *et al*., 2015) and compost application generally enhances soil physicochemical properties (Liu *et al.,* 2020). The control on the contrary had lesser values in all these parameters as there was nothing to boost the nutrients needed - it struggled to survive and there was poor growth.

The other two treatments which are: spent mushroom substrate and urea respectively had good values for all growth parameters but it wasn't as high as cow dung treatment. From the result it was observed that from week 3 - week 5, urea treatment had higher values than spent mushroom substrate for plant height, number of leaves, leaf length, but from week 6 - 8, there was decline in these values. This may result from the fact that Urea fertilizer contains only nitrogen and does not provide other essential nutrients such as phosphorus and potassium, which may also be necessary for optimal plant growth. So, in as much as nitrogen is needed for growth, there are other nutrients which are needed to help the plant develop better. Hence, from week 6 - 8, spent mushroom substrate had higher values than urea in plant height, number of leaves and leaf length. This will be as a result of the fact that nutritionally, maize requires high levels of N, K, and P (Setiyono *et al.,* 2010) and spent mushroom substrate is rich in macro and micronutrients, which are readily available to plants (Wang *et al.,* 2021) and can increase the organic content of the soil as well as improve its physicochemical characteristics (Becher *et al.,* 2021). This result is line with Alves e*t al*. (2022) who concluded that the use of a spent mushroom substrate (SMS) improves maize germination.

CONCLUSION

It is a well-known fact that the yield, reproductive growth, development, nutritional value depends on the fertility of the soil. So, if one has plans to increase productivity, it is advisable to apply fertilizers. The results revealed that the maize plant responded well to both organic and inorganic fertilizer - the best growth characteristics were obtained from buckets treated with cow dung.

RECOMMENDATION

Based on the results obtained from this research, cow dung is recommended as a good fertilizer for maize production. It promotes the growth and development also; it is easy to get and more economical. However, farmers should ensure that it is composted before use; this is because fresh cow dung contains high levels of ammonia and dangerous pathogens which might hurt crop roots.

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