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# Maize Growth Response on Soil Enhanced with SMS under Different Irrigation Interval.

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***Abstract****: Maize is an important crop for human nutrition, development and raw material for industrial production. The production of maize has recorded tremendous increase in the Nigeria economy, despite the economic, nutritional and medicinal importance, the production of this crop in Nigeria is still at the subsistence level. Thus, in order to boost the nation's economy and also reduce food scarcity, farmers should desist from over-reliance on rainfed agriculture. This study was conducted to determine the response of the growth and yield parameters of maize on soil amended with mushroom compost when subjected to different irrigation intervals. The study was conducted at the research and demonstration farm of Rivers State University, Port Harcourt, Nigeria. 2000g of mushroom compost was uniformly incorporated manually into treatment plots. The treatment combination were SMS with no irrigation, SMS with 3 days irrigation interval, SMS with 5 Days irrigation interval, SMS with 7 Days irrigation interval and control plot with no irrigation and no SMS which represents the natural conditions of the soil. Complete Randomized Design (CRD) with three replicates was utilized. Three stands of maize were planted on the subplot at spacing of 1m x 1m. The plant parameters measured were plant height, stem girth and yield. The results revealed that the highest average plant height was obtained from 5 days irrigation interval plot (2.116m), followed by 3 days irrigation interval, (1.931m), 7 days irrigation interval (1.902m), SMS with zero irrigation interval(1.702m), no SMS with zero irrigation (1.582m), stem girth and yield followed same trend. The highest mean yield(4200kg/ha) was obtained from 5 days irrigation interval subplot, followed by 7 days irrigation interval (3,800kg/ha), 3 days irrigation interval(3,000kg/ha), SMS with no irrigation interval (2,800kg/ha) and the lowest was the control plot (2,300kg/ha). There was highly significant difference at 1% and 5% level between the plant growth parameters. On the whole, the results showed that 5 days irrigation interval and SMS significantly impacted on the response of growth and yield parameters of maize on a sandy loam soil*

**Keywords: Maize, Spent Mushroom Substrate, Irrigation Interval.**

## 1. INTRODUCTION

Maize is of the grass family, Poaceae with botanical name Zeamay L. Maize has always been utilized by human for survival and sustenance. It is among the three most explored crops on earth, providing man with multi-uses, ranging from nutritional to economics values [1]. The production of maize has recorded tremendous increase in the Nigeria economy and Nigeria is the largest Africa producer of maize with about 8 Million tons [2,] [3] revealed that maize is an important crop for human nutrition, development and raw material for industrial production. Several reports confirm that maize is mostly used as the first source of animal feed, where the grains or its mash are used to feed animals [4, 5, 6]. Maize contains calcium 6%, Phosphorus, 30%, iron 2.5%, vita 0.015%, Ascorbic acid 11.40%, maize can be processed into livestock feed, corn flasks, paps, corn meal, alcoholic drinks, baking flour [7], the corn silk is been used to treat urinary tract infections, kidney stones, fluid retention, jaundice, high blood pressure and liver problem while the corn roots, leaves and silk can be boiled and its decoction used for bladder treatment [8] because it contains phytochemical secondary metabolites, hordeine and polyphenols despite the economic, nutritional and medicinal importance, the production of this crop in Nigeria is still at the subsistence level. One of the factors affecting the production of maize in Nigeria for export, reduction of food scarcity as well as poor economy is the over-reliance of farmers on rainfed agriculture. The total reliance on rainfall for the production of crop especially in the South-South region of Nigeria is an outdated practice birthed out of misconception that the region enjoys rainfall in abundance [9],[11] revealed that soil in the South- South zone of Nigeria is such that the movement of gravitational water is usually very slow which results to poor permeability, leading to high surface run-off. There is also high evaporation which is about one-half of the rainfall which indicated that only small fraction of the observed rainfall actually infiltrates and percolates in the plant root zone to enhance the growth performance of crops. Different crops has different water requirement and the same crop may have different water requirements at different place depending on the soil type, variation in climatic condition, method of cultivation and useful rainfalls etc. In most part of the world, moisture available in the crop root zone either by rainfall or underground water may not be sufficient for the requirement

of plant, so to achieve optimum plant growth there is need to make up the deficiency by adding water to the root zone through irrigation [11]. Organic materials are important soil additives that help to improve soil physical, chemical, and biological properties and the overall soil fertility [12]. In addition to productive yields, these organic materials have been beneficial for soil chemical and physical fertility and stability [13] Spent mushroom substrate has been proven to be a good soil amended for soil structure restoration [14] that is essential for agricultural production because it increases soil microbial activity, promotes soil drainage, provides substantial amount of plant, also a good source of organic matter and has a limiting effect on soil [15] [16] SMS also contains a wealth of nutrient compare to micronutrients that are found in the NPK fertilizer, making it a good option over chemical (Inorganic) fertilizer. However, [17] confirms that the use of inorganic fertilizers has not been able to sustain high productivity due to increase in soil acidity, nutrient leaching and degradation of soil organic matter and physical conditions. This study reveals the growth response of maize on soil amended with SMS under 3, 5 and 7 irrigation intervals.

## 2. Materials and Methods

### 2.1. Description of the study area

The study was conducted at the research and demonstration farm of Rivers State University, Port Harcourt, Nigeria, located on a GPS coordinate of latitudes 4°45' – 4°60' E and longitudes 6°55' – 7°56' N as shown in figure 1, during the 2021 cropping season. Port Harcourt is characterized by tropical rainforest vegetation with a rainfall ranging from 2000-2484mm per annum of which 70% occur between the months of May and August, The rest of the year is relatively dry with mean air temperature varying from 25 to 30°C [11] The soil type is ultisol (USDA classification) and its soil texture is sandy loam [18].

### 2.2 Planting and Cultural Practices

Three seeds of maize obtained from the Rivers State Ministry of Agriculture, Port Harcourt, Nigeria, was planted per stand. The maturity period of maize is about three months after planting. There were no biological or chemical control of weeds, and were removed manually whenever they spring up in order to prevent the weeds competing with the crops.

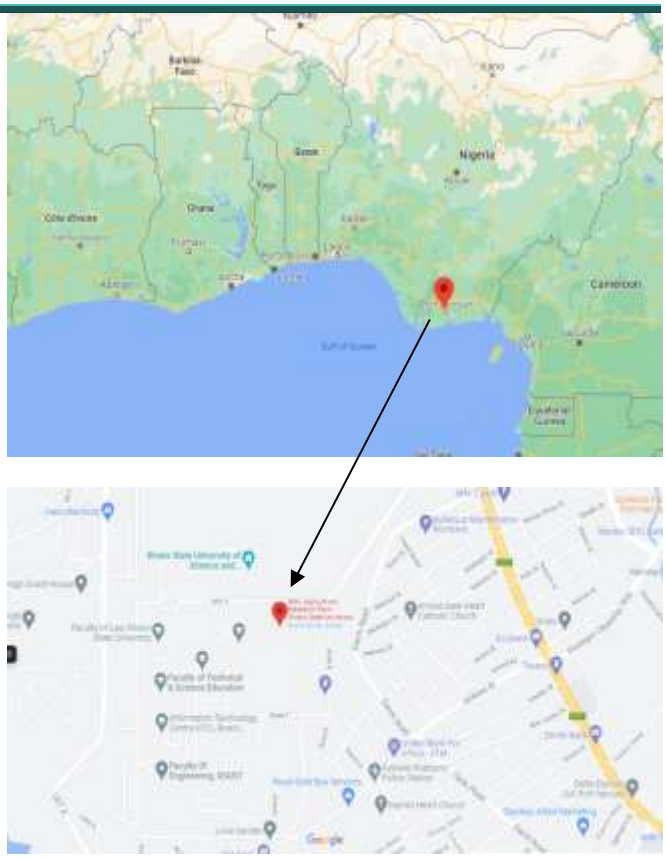


Figure 1: Goggle Map of Nigeria showing RSU, Research Farm.

### 2.3 Laboratory Analysis

The physical and chemical properties of soil which includes pH, Particle size distribution, Moisture content, Electrical conductivity, organic carbon, organic matter, Total Nitrogen, Available Phosphorus, Exchangeable K, Na, Mg, Ca, soil samples were collected with auger at 30cm depth before planting, after planting and at harvest, collected samples were taken to the laboratory for analysis. The methods adopted were those described by [19]. [20], [21].

### 2.4 Plant Parameters Determination

The average values of three plants of each sub-plot were used to determine leaf area and plant height three weeks after planting.

### 2.5 Yield

The yield of maize was calculated using the equation suggested by [22] as given as:

$$\text{Yield (kg/ha )} = \frac{\text{Crop weight per subplot(kg)}}{\text{Area of subplot}(m^2)} \text{x} 10000 m^2/\text{ha}$$

### 2.6. Statistical analysis

Duncan multiple range test was used to compare the variability in the growth and yield parameters at different irrigation interval [23]

## 3. Results and Discussion

The SMS properties suitable for the growth of Maize is yet to be ascertained, as spent mushroom compost selection for the production of turf recommends that pH should be between 6.0 and 8.0, carbon: nitrogen ratio should be below or equal to 30:1 while organic matter should be greater than 40% [24]. The spent mushroom compost used for this study meets the recommendations for SMS selection for the production of turf [16].The physical and chemical properties are main indicators used to assess soil quality. Table 1 shows the physical and chemical properties of the soil before and after addition of pent mushroom substrate and a harvest.

**Table 1. Physical and Chemical Properties of the S0oil**

| Sample Parameter | Before Addition of SMS | After Addition of SMS | At Harvest |
|---|---|---|---|
| Soil pH | 5.17 | 5.62 | 5.22 |
| Moisture Content (%) | 1.5 | 2 | 2.18 |
| Electrical Conductivity(µs/cm) | 71.4 | 358 | 92.17 |
| Organic Carbon (%) | 0.21 | 0.53 | 0.16 |
| Organic Matter (%) | 0.36 | 0.92 | 0.95 |
| Total Nitrogen (%) | 0.067 | 0.098 | 0.114 |
| Available Phosphorus (mg/kg) | 24.5 | 105 | 138 |
| Exchangeable K (cmol/kg) | 6.41 | 13.21 | 11.03 |
| Exchangeable Na (cmol/kg) | 15.22 | 17.39 | 16.56 |
| Exchangeable Mg (cmol/kg) | 0.4 | 2.8 | 3.78 |
| Exchangeable Ca (cmol/kg) | 1.4 | 5 | 9.5 |
| Sand (%) | 82 | 80.3 | 85.06 |
| Silt (%) | 13.6 | 16.26 | 13.73 |
| Clay (%) | 4.4 | 6 | 3.3 |
| Textural Class | Sandy loam | Sandy loam | Sandy Loam |

The physicochemical properties of the soil before adding SMS, after adding SMS and at harvest are presented in Table 1. Table 1 show that the pH of the soil increased from 5.17 before the experiment to 5.62 after addition of SMS and 5.22 at harvest. The acidic nature of the soil was not altered after adding SMS, which is in line with the findings of [ 6]. The soil moisture content increased from 1.5 % to 2% after addition of SMS and also increased to 2.18% at harvest due to addition of irrigation water.

SOC is known to play important roles in the maintenance and improvement of many soil properties. The addition of SMS increases the Organic Carbon in the soil from 0.21% to 0.53% and reduced to 0.16% at harvest which may be as a result of plant uptake. Soil organic matter content is one of the most important soil quality indicators of soil recovery [25], [26], [27] is a good sign for soil quality [28], before planting the soil organic matter was 0.36% and then increased to 0.92% after incorporating SMS. Soil EC indicates the mineralization of organic matter in soil [30], [31], [32], the addition of SMS increased EC value from 71. µs/cm to 358 µs/cm, and reduced to 92.17µs/cm at harvest which can be attributed to high content of solutes in the nutrient composition of fraqment [32] which also serves as a measure of the presence of nutrients for both cations and ions [33] and the reduction of EC would be due to leaching and plant uptake [16],[34]. Table 1 further revealed that available P, Ca, K, Na and Mg increased from 24.5mg/kg, 1.4cmol/kg, 6.41cmol/kg, 15.22cmol/kg, and 0.4cmol/kg to 105 mg/kg, 5cmol/kg, 13.21cmol/kg, 17.39cmol/kg, 2.8cmol/kg respectively in the treatment plots and decreased at harvest which conforms to the findings of [35] who revealed that treatment of soil with SMS increases available P, K, Ca and Mg contents in the soil. However the reduction at harvest may be due to plant uptake.

The effects of the application of irrigation at different levels and addition of SMS on the growth parameters of maize at the end of Eighteen (18) Weeks After Plant (WAP) as presented in Table 2 and

**Table 2: Plant Height (m)**

| WAP | Control Plot | 0 Day Irrigation Interval + SMS | 3 Days Irrigation Interval + SMS | 5 Days Irrigation Interval + SMS | 7 Days Irrigation Interval + SMS |
|---|---|---|---|---|---|
| 3 | 0.107 | 0.187 | 0.192 | 0.217 | 0.198 |
| 4 | 0.187 | 0.213 | 0.224 | 0.243 | 0.218 |
| 5 | 0.218 | 0.26 | 0.275 | 0.368 | 0.266 |
| 6 | 0.252 | 0.303 | 0.322 | 0.405 | 0.308 |
| 7 | 0.302 | 0.383 | 0.402 | 0.508 | 0.400 |
| 8 | 0.386 | 0.414 | 0.520 | 0.638 | 0.465 |
| 9 | 0.432 | 0.506 | 0.612 | 0.724 | 0.530 |
| 10 | 0.504 | 0.584 | 0.706 | 0.818 | 0.642 |
| 11 | 0.633 | 0.640 | 0.813 | 0.952 | 0.728 |
| 12 | 0.763 | 0.792 | 1.386 | 1.247 | 0.936 |
| 13 | 0.882 | 0.964 | 1.509 | 1.433 | 1.222 |
| 14 | 1.246 | 1.302 | 1.672 | 1.563 | 1.324 |
| 15 | 1.325 | 1.442 | 1.738 | 1.700 | 1.500 |
| 16 | 1.414 | 1.544 | 1.822 | 1.878 | 1.572 |
| 17 | 1.508 | 1.625 | 1.852 | 2.046 | 1.766 |
| 18 | 1.582 | 1.702 | 1.931 | 2.116 | 1.902 |

*WAP = Week after Planting

**Table 3: Leaf Area ($cm^2$)**

| WAP | Control Plot | 0 Day Irrigation Interval + SMS | 3 Days Irrigation Interval + SMS | 5 Days Irrigation Interval + SMS | 7 Days Irrigation Interval + SMS |
|---|---|---|---|---|---|
| 3 | 0.011 | 0.018 | 0.019 | 0.025 | 0.02 |
| 4 | 0.013 | 0.022 | 0.023 | 0.03 | 0.023 |
| 5 | 0.018 | 0.023 | 0.027 | 0.038 | 0.026 |
| 6 | 0.025 | 0.029 | 0.034 | 0.048 | 0.030 |
| 7 | 0.028 | 0.034 | 0.039 | 0.056 | 0.038 |
| 8 | 0.033 | 0.038 | 0.047 | 0.064 | 0.045 |
| 9 | 0.037 | 0.049 | 0.056 | 0.073 | 0.052 |
| 10 | 0.043 | 0.052 | 0.065 | 0.077 | 0.056 |
| 11 | 0.053 | 0.056 | 0.07 | 0.082 | 0.061 |
| 12 | 0.06 | 0.062 | 0.076 | 0.086 | 0.065 |
| 13 | 0.063 | 0.066 | 0.079 | 0.089 | 0.068 |
| 14 | 0.070 | 0.074 | 0.083 | 0.093 | 0.075 |
| 15 | 0.076 | 0.08 | 0.088 | 0.097 | 0.081 |
| 16 | 0.083 | 0.087 | 0.093 | 0.099 | 0.084 |
| 17 | 0.085 | 0.090 | 0.096 | 0.101 | 0.086 |
| 18 | 0.088 | 0.095 | 0.099 | 0.104 | 0.090 |

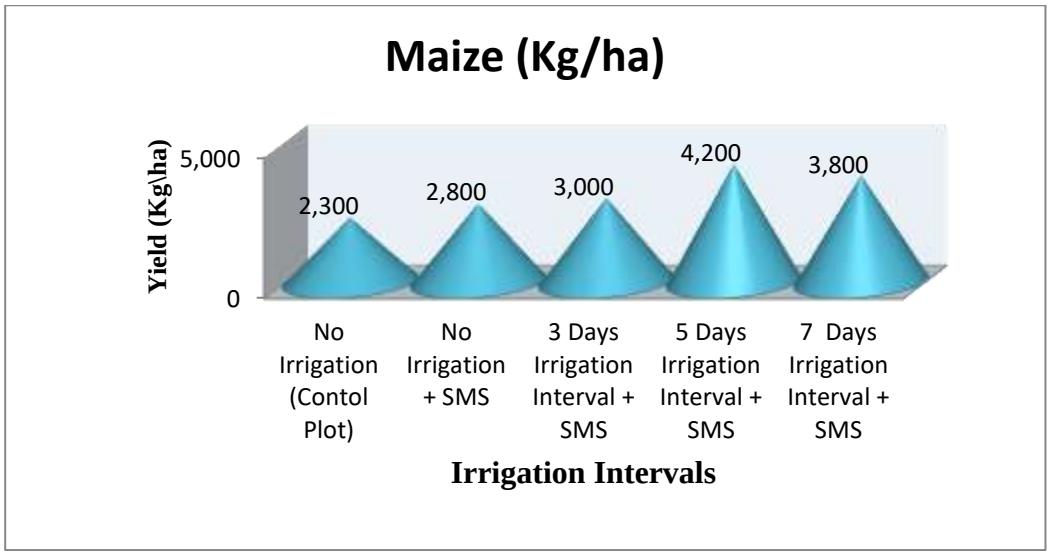


Figure 2 shows the Values of Average Maize Yield at Control Plot, 0, 3, 5 and 7 Days Irrigation Interval

**Table 4: Summary of Analysis of Variance (ANOVA)**

| Parameter | Source of Variation | Degree of Freedom | Sum of Square | Mean Square | $F_{cal}$ | $F_{tab}$ 5% | $F_{tab}$ 1% |
|---|---|---|---|---|---|---|---|
| **Plant Height** | Treatment | 4 | 0.2311 | 0.0578 | 13.76** | 3.48 | 5.99 |
| | Experimental error | 10 | 0.0042 | 0.00042 | | | |
| | Total | 14 | 0.2353 | | | | |
| **Leaf Area** | Treatment | 4 | 0.0018 | 0.00045 | 22.5** | 3.48 | 5.99 |
| | Experimental error | 10 | 0.0002 | 0.00002 | | | |
| | Total | 14 | 0.002 | | | | |

**Highly significant

Figure 2 indicated that the yield at the control plot (2,300kg/ha) with no SMS and no irrigation applied which represents the natural conditions of the soil was less than subplot (2,800kg/ha) with SMS and no irrigation, which is attributed to the addition of SMS to the soil enhances the crop growth and yield [16].
Table 4 presents the summary of analysis of variance on plant height and leaf area between experimental plots.

Table 1 and 2 presents the effects of the different irrigation interval on the growth parameters of maize at the end of eighteen weeks after planting. Subplots comprises of control plot, SMS with zero irrigation, 3 days irrigation interval, 5 days irrigation interval and 7 days irrigation interval. Plant height relationship after 18 weeks of planting indicated that 5 days irrigation interval subplot recorded the highest plant height of 2.116m, followed by 3 days irrigation interval subplot (1.931m), next to 7 days irrigation interval (1.902m), SMS with zero irrigation interval (1.702m) and no SMS and zero irrigation (control plot) which represents the natural condition of the soil recorded the lowest plant height of 1.582m. The highest average leaf area was obtained from 5 days irrigation interval (0.104cm$^2$), followed by 3 days irrigation interval (0.099 cm$^2$), SMS with zero irrigation interval subplots (0.095cm$^2$), 7 days irrigation interval (0.090cm$^2$) while the control plot recorded the lowest plant height of 0.088cm$^2$ . Also the highest value of yield obtained was 4200kg/ha from 5 days irrigation interval while 7 days irrigation interval (3,800kg/ha), followed by 3 days irrigation interval(3,000kg/ha), SMS with no irrigation interval (2,800kg/ha) and the least was the control plot (2,300kg/ha) as shown in figure one. This can attributed to the impact of the irrigation interval on the growth and yield parameter of maize which is similar to the findings of [9]. From the findings of this study, 5 days irrigation interval seems to have a better water use efficiency which indicates that the moisture level was within the readily available moisture zone. The highest irrigation interval of 7 days must have made the

moisture level to exceed the lower available limit and hence into the wilting point range, causing the plant to undergo some moisture stress [9, 36, 37].

## CONCLUSION

Application of irrigation and SMS greatly enhanced the growth and yield of Maize on a sandy loam soil. Thus, the 5 days irrigation interval gave the highest plant height, and stem girth, followed by the 3 days irrigation interval, 7 days irrigation interval, SMS and no irrigation, and no SMS and no irrigation recorded the lowest, while 5 days irrigation interval also gave the highest yield, followed by 7 days irrigation interval, SMS and no irrigation, and no SMS and no irrigation recorded the least yield.

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