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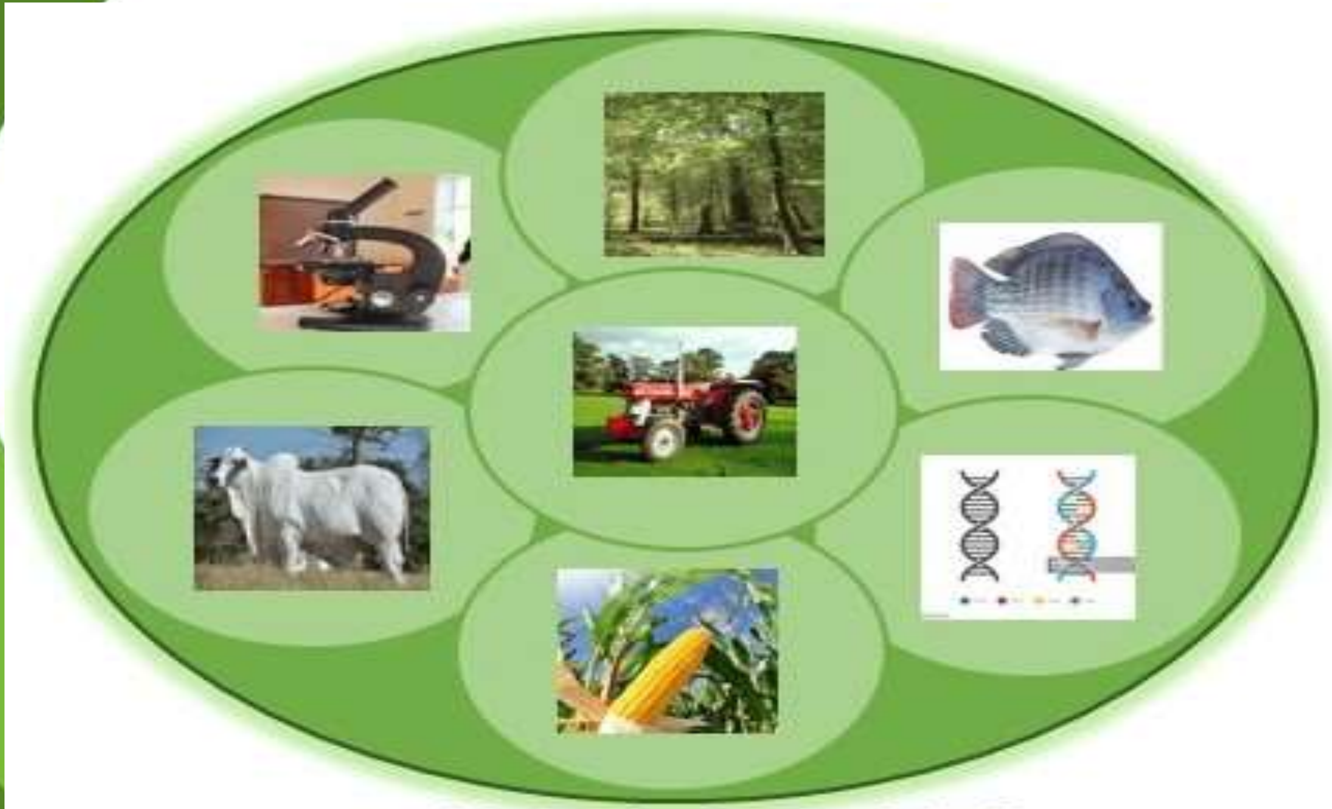

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INVESTIGATING THE IMPACT OF BURNT, UNBURNT, AND MIXED COCONUT (COCOS NUCIFERA L.) HUSK ON GROWTH AND YIELD OF MAIZE (ZEA MAYS)

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ABSTRACT

Coconut husk, a readily available agricultural waste, has been explored as a potential organic amendment to improve soil fertility and crop productivity. This study examines the effects of burnt, unburnt, and a combination of burnt and unburnt coconut husk on the growth and yield of maize (Zea mays L.). The unburnt and burnt coconut husks used for the experiment were sourced from Yaba College of Technology, Odoiragushi, Epe, Lagos State and its environment. The test crop, maize (Oba super 2) seeds were sourced from the National Institutes of Horticulture Research (NIHORT). Treatments applied were burnt coconut husk (BCH) at 5 tha-1, burnt coconut husk (BCH) at 10 tha-1, unburnt coconut husk (UBCH) at 5 tha-1, unburnt coconut husk (UBCH) at 10 tha-1, mixture of burnt and unburnt coconut husk (BCH + UBCH) at 5 tha-1, mixture of burnt and unburnt coconut husk (BCH + UBCH) at 10 tha-1, and control (no treatment). The burnt and unburnt coconut husk reduced the acidity of the soil from 6.9 to 6.05 and increased the organic matter content from 2.8% to 4.3%. The burnt and unburnt coconut husks at different inclusions released nutrients for the growth and development of maize. Five (5) tha-1 inclusion of burnt coconut husk expressed higher reproductive development by producing eight (8) cobs and cobs weight of 2.20 kg which were higher than other treatments, The study concludes that coconut husk, in its various forms, has potentials as a sustainable organic treatment for maize production with burnt coconut husk at 5 tha-1 being recommended for farmers for optimum growth and yield of maize.

Keywords: Burnt, growth, husk, maize, unburnt, yield,

Introduction

Maize (Zea mays L.) is one of the leading cereal crops in the tropics, providing a source of food and oil for human beings and feed for animals along with diverse raw materials for agro-based industries (Zaidun et al., 2019). It is a vital crop worldwide and can grow in different types of soil and a wide range of climates (Agegnehu et al., 2016). It is a very nutritious crop which provides us with phytochemical compounds that can prevent many chronic diseases (Shah et al., 2016).

In recent years maize has been the source of quality Carbohydrate, which can play a significant role in reducing global vitamin A shortage and protein-energy malnourishment (Galani et al., 2022). It can provide an energy density of 365 kcal 100 g-1 and contains approximately 72% starch, 10% protein, and 4% fat (Ranum et al., 2014). The application of burnt organic materials to the soil by converting organic waste is now one of the new eco-friendly management tools worldwide (Gonzaga et al., 2018). Burnt organic materials is a Carbon-rich organic material that has undergone the pyrolysis process of biomass thermal decomposition when heated to temperatures usually between 300 and 1000 °C under low oxygen concentrations (Karamova et al., 2023). Used as a soil amendment, burnt organic materials can recover soil fertility and plant growth, improve Carbon sequestration, assist waste management, and immobilize pollutants (Jeffery et al., 2022).

Burnt organic materials have a high surface area and high organic matter. It is therefore an appropriate habitat for soil micro- and macroorganisms. It can therefore increase soil biota by improving soil quality (Lehmann et al., 2015). Burnt organic materials has been reported to have both direct and indirect influences on physical, chemical and biological properties, which can have impacts on plant growth, nutrient use efficiency and yield (Diatta et al., 2020).

The addition of burnt organic materials to agricultural land will provide considerable benefits, such as improving the physical and chemical properties of the soil, retention of water and preventing the soil from erosion, the surface area of the land will expand for chemical reactions to increase the rate of nutrient absorption in the soil. Thus, indirectly increasing crop production (Adekiya et al., 2023).

Coconut husk is commonly available locally and in abundance. It causes significant green energy waste (Obeng et al., 2020), detrimental to human health, environmental pollution, greenhouse effects, global warming and climate change issues (Ferronato and Torretta, 2019; Jain et al., 2014). Therefore, an alternative method of coconut waste management is highly desired. Hence this study is aimed at evaluating the effectiveness of burnt coconut husk on the growth and yield of maize.

Materials and Methods

Experimental site

The field experiment was conducted at the Teaching and Research Farm at Yaba College of Technology, Odoragushin, Epe Campus Student Research Farm (Longitude 3058” 56’ E and Latitude 6038”36’ N) above sea level (Goggle Earth,2021), during the wet and dry season of 2022. It lies on km 16, along Epe, Ijebu-Ode road, Epe, Lagos in the lowland rainforest vegetation zone within South-Western Nigeria.

Sourcing and preparation of coconut husk samples

The coconut husk used for the experiment was sourced from Yaba College of Technology, Epe Campus and her environment. The test crop is maize (Oba Super 2). The maize seeds were sourced from the National Institution of Horticulture Research (NIHORT), Ibadan, Oyo State.

The coconut husks were cut into smaller pieces and spread for air drying at room temperature until properly dried. Thereafter, the nutrient compositions of the coconut husks were determined through analysis in the laboratory. Burnt coconut husk was prepared through auto thermal shell combustion in a vertical drum (1.5m high and 1.5m diameter). Combustion was conducted for 8 hours and then cooling was allowed for 12 hours (one night). During pyrolyzing, the temperature was regulated between 200OC – 310OC (average temperature of 250OC). After cooling, burnt coconut husk was grounded and pulverized.

Soil analysis
Initial soil samples (0 - 15 cm layer) were randomly collected at different points with the aid of soil auger on the experimental site before amendments were applied, these were bulked and sub sampled for chemical analysis (pH, organic matter, total nitrogen, exchangeable bases, phosphorus, magnesium, calcium).

Site preparation and experimental design
The experimental site was manually cleared and leveled using cutlasses and hoes respectively. Measurement of plot and sub-plots was carried out using measuring tape, rope and pegs. The land area of the plot was measured as 40m by 7.5 with a sub-plot area of 5m by 1m. Tilling of the sub-plots into ridges with the hoe and cutlass was carried out. There are seven (7) treatments laid out in a Randomized Complete Block Design (RCBD) with three (3) replicates. Application and incorporation of coconut husk burnt, unburnt and mixture of burnt and unburnt coconut husk was done two weeks before sowing to allow the decomposition of organic matter.

Treatments applied were:
T1- 0 tha-1 -control
T2 - 5 tha-1 - Burnt Coconut Husk (BCH)
T3 - 10 tha-1 - Burnt Coconut Husk (BCH)
T4 - 5 tha-1 - Unburnt Coconut Husk (UBCH)
T5 - 10 tha-1 - Unburnt Coconut Husk (UBCH)
T6 - 5 tha-1 - Mixture of Burnt and Unburnt Coconut Husk (BCH + UBCH)
T7 – 10 tha-1 - Mixture of Burnt and Unburnt Coconut Husk (BCH + UBCH)

Planting and cultural practices
Maize seeds (Oba Super 2) were sown after carrying out seed viability test. Weeding was done manually at two (2) weeks intervals till harvest. Watering was also done adequately in the morning and evening when there was no rain as appropriate. Data were collected at two (2) weeks interval till maturity.

Data collection and analysis
Data collected were number of cobs per subplot, which was done by physical counting, while fresh cob weight (g/kg) was determined using weighing balance/scale.
Data collected were subjected to Two Way Analysis of Variance (ANOVA). Analysis were done using R statically software 4.3.2 version. The difference in means were considered significant at P≤ 0.05 by HSD.
Soil and nutrient composition analysis were done using standard methods. Soil pH was determined using pH glass electrode meter (Mclean, 1982). The organic carbon content of the samples was also determined using the wet oxidation method (Nelson and Sommers, 1996). Nitrogen was determined by modified micro-Kjeldahl digestion techniques (Jackson, 1964). Phosphorus was extracted using Bray-1 (Bray and Kurtz, 1945). Calcium and Magnesium were determined using Atomic Absorption Spectrophotometer.

Results
Physico-Chemical Properties of Pre and Post-Planting Soil Used for the Study.
Table 1 shows the result of the physico-chemical properties of the soil before and after the experiment. The textural class of the soil was loamy sand, Soil has pH of 6.9 indicating the soil was slightly acidic, the organic carbon content of 1.66% which is quite low indicating low microbial activities (Zwietan et al., 2011). The total Nitrogen was 1.24%, available

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phosphorus (9.46), Calcium (3.12), Potassium (0.16), Magnesium (1.02) which indicates low nutrient composition and this made the soil suitable for the experiment (Janeau et al., 2014).

The result of post planting soil shows, the soil to be more acidic with a value of 6.05 against the initial of 6.9. This can be attributed to an increase in exchangeable H+ from 0.8 to 0.11 which is a result of the removal of cations during nutrient uptake (Ippolito et al. 2020) and leaching as a result of incessant rainfall during cultivation as experienced in the tropics.

Also, this increase in hydrogen ion concentration is responsible for acidity reflected in the increase in the micronutrients as observed in Cu, Fe, Zn and toxicity of Mn. This is always the effect of acidity on micronutrients in acidic soil as observed in soil reactions (Hass et al. 2012).

Also, total nitrogen N, CEC, Base saturation% (percentage), and Available phosphorus and calcium were reduced due to nutrients uptake while exchangeable potassium and magnesium increased in composition due to the effects of burnt coconut husk on the soil (Borno et al., 2018).

Table 1: Physico-Chemical Properties of Pre and Post-Planting Soil Used for the Study.

Soil Properties	**Units**	**Pre Planting**	**Post Planting**
PH		6.9	6.05
Organic C (%)	(%)	1.66	2.64
Total Nitrogen (%)	N(%)	1.24	0.24
Exchangeable bases	K (Cmol\kg)	0.16	0.56
Exchangeable	H^+ (Cmol\kg)	0.8	0.11
CEC	Cmol\kg)	15.05	13.54
Base saturation	((%)	9.42	7.38
P	Av.p (mg\kg)	9.46	8.75
Mg	Mg (cmol\kg)	1.02	2.69
Cu	Cu (mg\kg)	1.32	3.00
Fe	Fe (mg\kg)	2.67	5.70
Zn	Zn (mg\kg)	2.67	5.70
Mn	Mn(mg\kg)	6.23	26.7
Ca	Ca (Cmo\kg)	3.12	2.90
Particle size		<0.05mm	<0.05mm
Texture class		Loamy sand	Loamy sand

Nutrient Composition of Coconut Husks used for the Experiment

The nutrient composition of burnt and unburnt coconut husk used in the experiment is shown in Table 2. The unburnt coconut husk has neutral pH of 7 while the burnt coconut husk has pH of 11 indicating an alkaline pH (Lehmann and Joseph, 2009).

The nutrient composition of P, Ca, Mg, C, K, Fe, Zn and Cu were higher in burnt coconut husk than unburnt coconut husk thus making it a more suitable soil amendment for crop production (Borno et al. 2018). Unburnt coconut husk has a higher nitrogen content of 2.5% than burnt coconut husk which can contribute to more vegetative growth of maize (Yuan et al. 2011). Hence, the application of burnt coconut husk helped to increase the concentration of some nutrients in the soil as evident in the nutrient composition of burnt coconut husk (Diego et al. 2020).

Table 2: Nutrient Composition of Coconut Husks used for the Study

TOTAL%	PH	N%	P%	Cu%	K %	Zn%	Ca %	Fe%	Mg%	C%
Unburnt Coconut husk	7.0	2.5	0.5	0.5	1.5	0.5	0.5	0.3	0.6	0.7
Burnt Coconut Husk	11	2.0	1.0	2.7	2.0	4.3	4.4	37.3	1.0	0.21

Effect of Burnt, Unburnt and Mixed Coconut Husk on Number of Cobs at 8, 10 and 12 Weeks after Planting (WAP).

Table 3 shows the effect of treatments of burnt coconut husk, unburnt coconut husk and mixed coconut husk on number of cobs at 8, 10 and 12 WAP. The result shows no significant difference in all different treatments on a number of cobs at 8, 10 and 12 WAP at P<0.05. However, At 8 WAP, T6 had the highest value with the least value in T4, At 10 WAP, T2 had the highest value with least value in T5, At 12 WAP, T2 had the highest value with least value in T1, T4, and T5. T2 had greater effects on a number of cobs than any other treatment.

Table 3: Effect of Burnt, Unburnt and Mixed Coconut Husk on Number of Cobs at 8, 10 and 12 Weeks after Planting (WAP).

Treatment	WK 8	WK10	WK12
T1	2.67+_2.08	5.67+_0.58	5.00+_1.00
T2	3.00+_1.73	8.33+_0.58	8.00+_0.00
T3	3.33+_2.51	6.33+_1.53	6.00+_2.00
T4	1.33+_0.58	6.00+_1.00	5.00+_1.00
T5	3.00+2.65_	5.67+_1.53	5.00+_1.00
T6	3.67+_1.15	6.33+_2.52	6.69+_0.58
T7	2.00+_1.00	6.67+_2.08	6.00+_1.00

Value represents the highest square means (HS-means)+_standard error.HS-means were separated using the highest significant.Difference and HS-means within a column followed by different letters are significantly different at P<_0.05. T1= burnt (5tons\ha), t2= burnt (10 tons/ha), T3= Unburnt (5 tons/ha) T4= Unburnt (10 tons/ha), T5=Unburnt +burnt(5tons/ha), T6= Unburnt +burnt (10tons/ha), T7= control, Std r=Standard r.

Effect of Burnt, Unburnt and Mixed Coconut Husk on Weight of Cobs at 12 WAP.

Table 4 shows the effect of burnt coconut husk, unburnt coconut husk and mixed coconut husk on the weight of cobs at 12 WAP. It was observed from the table that, there were no significant difference in all the treatments applied on the weight of cobs at 12 WAP at P>0.05. However. At 12 WAP, T2 had the highest value with the least value in T4 it can be seen that T2 played a significant role in the weight of cobs of maize cultivated during the experiment.

Table 4: Effect of Burnt, Unburnt and Mixed Coconut Husk on Weight of Cobs at 12 WAP.

Treatment	WK 12
T1	1.57+_0.50
T2	2.20+_0.26
T3	1.50+_0.88
T4	1.37+_0.32
T5	1.60+_0.60
T6	2.10+_0.40
T7	1.50+_0.17

Discussion

The soil used for the study was Loamy Sand in texture with low nutrients required for plant growth and this can be related to the low quantity of organic carbon in the soil which was as a result of low microbial activities in this soil (Zhuo et al., 2013). This proves that the soil has been used for cultivation throughout some time and has not been allowed to replenish its nutrients through fallowing. Hence, application of treatment is required to increase the fertility of the soil.

It was also observed that burnt coconut husk had higher pH, K, Ca, Mg, Fe, Cu, Zn, C. (Hammes and Schmidt, 2009) which makes it of better quality than unburnt coconut husk in terms of improving growth and development.

Results obtained showed that plot applied with burnt coconut husk produced higher numbers of cobs from 10 to 12 weeks after planting as compared to control and plot applied with unburnt coconut husk. Burnt coconut husk treatment at 5 tons/ha produced a higher number of cobs from 10 to 12 WAP compared to other treatments. This is in line with the finding of Lorn et al., (2019) who reported that amendment of soil with rice husk biochar and siam weed biochar improved the yield of tomato plants without fertilizer. Jeffery et al., (2020)) showed that when there is an increase in pH there is also an increase in the availability of nutrients, which may explain the effect of burnt coconut husk addition to the soil. The addition of burnt coconut husk at 5tons/ha significantly improved yield and weight of fresh cobs of maize. It was also observed that highest number of cobs which reflected in the final productivity may be attributed to the presence of potassium in the pyrolyzed plant materials which enhances flowers, fruit formation, and yield of crops. This finding is in line with Diego et al., (2020) who reported that addition of rice husk biochar can improve maize productivity and water use productivity. The improvement in water productivity can be attributed to the change in total porosity and soil bulk density, which may have improved the hydraulic conductivity of the soil and its ability to retain water and make it available for crop use (Ajayi and Rainer, 2017, Faloye et al., 2019; Sun, 2019).

Conclusion

Incorporating burnt, unburnt, and mixed coconut husk into maize production has been proving to increase both growth and yield of maize. This could be because coconut husk treatment can enhance soil fertility due to its nutrient content thereby improving maize productivity.

Recommendation

Burnt coconut husk at 5 tha-1 was observed to be the best, followed by a mixture of burnt and unburnt at 10 tha-1 and unburnt at 5 tha-1 as they increased the growth and yield of maize compared to control. So therefore, 5 tha-1 of burnt coconut husk is recommended for maize production in the study area.

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