

Rice Husk Dust and NPK improve Soil Chemical Properties and Growth Response of

Jatropha

Abstract

The present study investigated the combined effect of rice husk dust (RHD) (0.1.2.3.4 and 5 ton ha⁻¹) and NPK 10:10:10 fertilizer (0, 1, 2, 3, 4 and 5 ton ha⁻¹) arranged factorially in Randomized Complete Block Design(RCBD)on selected soil fertility indices (pH, organic carbon, organic matter, total nitrogen, available phosphorus, exchangeable bases, exchangeable acidity and effective cation exchange capacity) and growth parameters of Jatropha (number of leaves, plant height, number of branches and stem girth) in an ultisol of southeastern Nigeria. Results showed significant ($P<0.05$) improvement in all soil chemical properties and growth parameters of plant compared to control which had no treatment. However, the effects varied with treatment levels and interactions. While the effects increased with rate of application, interactions consistently showed superior effect on all parameters studied. Thus, combining rice husk dust (RHD) and NPK may increase the soil fertility and growth of Jatropha. Treatments combination of 5tonha⁻¹ RHD and 3tonha⁻¹ NPK and 5tonha⁻¹ RHD and 5tonha⁻¹ NPK relatively gave the most appreciable result in soil chemical properties and growth of Jatropha respectively, thus are recommended.

Keywords: Soil fertility, *Jatropha curcas*, fertilizers and agronomic parameters

Introduction

Energy is fundamental to all human activities (Osueke and Ezugwu 2001). It has a major impact on every aspect of our socio-economic life. Aransiola, *et al.*, (2012) noted that future economic growth will depend crucially on long-term availability of energy from sources that are affordable, accessible and environmentally friendly . However, the rapid population growth and the continuous depletion of the over dependent non-renewable crude oil reserves have led to serious global energy crisis. Horn (2014), revealed that as at the year 2010, the world consumed nothing less than 35 billion barrels of oil per year. With this fact, more dependants are on the oil producing nations, such as Nigeria, Mexico

Nigeria is a country that despite its abundant energy resources, still faces energy crisis such as epileptic electric supply, shortage of petroleum products and incessant increase in prices of fuel. These realities have a boost to the search for renewable and sustainable alternatives to fossil fuels, which must be technically feasible, economically competitive, environmentally acceptable and easily available (Dermibas, 2009; Lateef *et al.*, 2014). Research showed that a very common plant in the tropics and especially Nigeria, Jatropha can provide bio-diesel from its seed (Lateef *et al.*, 2014).

Jatropha curcas plants are usually found economically un-useful and invaluable, except when they are used as fences for house, a factor that has limited its propagation in Nigeria. Jatropha plants which are abundantly found in abandoned lands can be easily propagated by cuttings in arid and semi-arid conditions and is well effective in erosion control Essien, (2016)-

Despite the energy supply potentials and the economic relevance of Jatropha, studies on the commercial production of the plant using conventional nutrient input programmes is still limited.

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Agronomists have long recognized the benefit of maintaining and increasing soil organic matter and one of the organic fertilizer sources is rice husk dust (Njoku *et al.*, 2015). During rice refining processes, the husks are removed from grains. It is of little commercial value and because of its high silicon dioxide content; it is not useful to feed either human or cattle (Nwaite, *et al.*, 2019), but can be incorporated into the soil to enhance soil fertility and crop productivity. For example, organic modification of soil with rice husk was found effective in **improving the nutrient status and thus increased** the yield of many crops like cowpea and rice (Njoku *et al.*, 2015). The increasing heaps of rice husk around rice mills in Ebonyi State and the evident that there will be continuous growth of this heaps due to the present federal government policies on ban on rice importation may in long-run become a threat to our environment if nothing is done to remove these wastes.

Considering the present and future scenarios of energy prospects occasioned by poor electricity supply and the decline in the quality and quantity of Nigerian crude oil, there is urgent need to explore the potentials of rice husk dust and NPK fertilizers on commercial *Jatropha* production for sustainable energy supply in Ebonyi State. This study was therefore designed to investigate the combined effect of decomposed rice husk and NPK fertilizers on soil fertility maintenance and growth of *Jatropha* in an ultisols of southeastern Nigeria.

Materials and Methods.

Experimental Site

The research was conducted at the Teaching and Research Farm, Department of Horticulture and Landscape Technology, AkanuIbiam federal polytechnic Unwana from April **2020 to October, 2020** under rainfed conditions. Geographically, Unwana is latitude 5^o48'N and longitude 7^o55'E The climate and vegetation type are generally humid tropical rainforest with annual rainfall of about 3500mm and daily temperature range of - 21°C - 32°C ((Nwabgara, 2007). According to Njoku *et al.*; (2006), the temperature is generally high throughout the year with annual relative humidity of between 60-80%.The soils which are derived from shale and sand stone belong to the order 'Ultisol' and have been classified as typic hapludult (Federal Department of Agriculture and land Resources, 1985; Nwaogu and Ebeniro, 2009). Table 1 is the representation of the results of some physical and chemical properties of the soil used for the study.

Table1. Some physical and chemical properties of the soil and rice husk dust (RHD) used for the study.

Properties	Values	RHC
Sand (%)	58.13	-
Silt (%)	11.58	-
Clay (%)	35.29	-
Texture	Clayey – loam	-
pH (H ₂ O)	4.00	8.00
pH (CaCl ₂)	3.56	7.31
Org. C. (%)	1.58	3.10
Org. M (%)	2.75	
Total N (%)	0.13	2.82
Av. P (mg/kg)	9.21	21.23
Ca (cmol. /kg)	3.03	5.59
Mg (cmol. /kg)	1.21	2.22
K (cmol. /kg)	0.30	1.87
Na (cmol. /kg)	0.01	0.14
Exc. Acidity	2.44	-
ECEC	6.99	-

The soil used for the experiment was relatively rich in soil nutrient, but was highly acidic indicating its inability to release nutrients especially phosphorus to growing crops (Brady and Weil, 2008)

Experimental materials.

Rice husk was obtained from a local rice mills in Afikpo, Ebonyi State, Nigeria, while the Jatropha seeds used for this experiment were obtained from the National Institute of Horticulture sub-station, Umulolo, Okigwe, Imo State. Similarly, the nutrient compositions of the RHD used for the study is shown in Table 1. Results showed that rice husk dust was rich in nutrients including organic carbon, available phosphorus and basic cations. Worthy of note are the high content of calcium and nitrogen. Other Researchers have also reported high nutrient content in rice husk (Njoku and Mbah, 2012; Paul *et al.*, 2007; Mansaray, 2007). According to Gailhre *et al.*, (2013), rice hull contains numerous elements essential for plant growth, including nitrogen, phosphorus and potassium.

Nursery establishment and management

The Jatropha seeds were sown in polythene bags filled with free-draining growth media containing adequate organic matter. Growth media containing a mixture of sand, topsoil and poultry manure at the ratio of 1:1:1 was used for raising the seeds. All nursery management practices such as watering, weeding, pest control were observed throughout the three months nursery period.

Field Experiment.

A Randomized Complete Block Design (RCBD) in factorial with three blocks (replications) was used for the study. The experiment covered a total land area of 52, 000m² (400m x 130m). Each blocks consisted of 36 sub-plots measured 1.8m x 1.8m in area with spacing of 1.0m between sub-plots and 2.0m between blocks. Thirty six (36) treatments in total comprising of six rates (0, 1, 2, 3, 4, and 5 tonha⁻¹) Rice Husk Dust and six rates (0, 1, 2, 3, 4, and 5 tonha⁻¹) NPK, replicated three times were randomly assigned to each treatment unit.

Seedlings were transplanted one month after treatment applications with one seedling per plot, and these gave a total of one hundred and eight (108) observational units. The transplanting to soil in the field was done when the plants reached an average height of 30 cm and developed 5-6 true leaves.

Data Collection

At 6 months after planting the following agronomic parameters were collected: plant height: measured as the length from the base of the plant to the tip of the shoot with the aid of a meter, stem girth by measuring with a caliper, number of leaves and branches by counting.

Similarly, at 6 month of growth soil samples were taken from each plot comprising of 36 samples replicated 3 times to give a total of 108 sample and the following chemical parameters were determined according to standard methods: Particles size distribution: This was determined using the Bouyocous hydrometer method as described by Benton (2001). Soil pH was determined in soil to water and soil to CaCl₂ at the ratio of 1:2.5, using glass electrode pH meter (Udo *et al.*, 2009). Organic carbon was determined by the wet oxidation method of Walkley and Black as described by Pansu and Gautheyrou (2006) and the value of organic carbon was multiplied by 1.742 to obtain organic matter. Total nitrogen determination was done by the macro Kjeldahl digestion method (Simmons *et al.*, 1994). Exchangeable acidity was determined by the 1M KCl extraction procedure as described

by Udo *et al.*, (2009). Exchangeable basic cations (K^+ , Ca^{2+} , Mg^{2+} , Na^+) were determined by the ammonium acetate method (Carter and Gregoich, 2008). Effective Cation Exchange Capacity (ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al.*, (2009). Base Saturation was obtained mathematically with:

$$BS (\%) = \frac{TEB}{ECEC} \times \frac{100}{1}$$

BS = Base saturation, TEB = Total Exchangeable Bases, ECEC = Effective Cation Exchange Capacity

Statistical Analysis

All data were subjected to (ANOVA) (Steel and Torrie, 1980) using GENSTAT 2009 version and means that showed significant difference were separated using Least Significant Difference (LSD) test at 5% level of significance.

Result and Discussion

Effect of Rice Husk Dust and NPK Fertilizer on Soil Chemical Properties.

The combined effect of rice husk dust and NPK on selected soil chemical properties is represented in Table 2. Results showed that soil pH was significantly affected following rice-husk dust and NPK application both as single and combined application. Increased RHD addition consistently increased the pH, while on the other hand, consistent addition of NPK presented slight decreasing trend on soil pH. This is in line with the observation of Odedina *et al.* (2003), who reported that organic wastes increased soil pH due to the abundance of alkaline earth materials. Similarly, Mbah and Onweremadu (2009) and Munecheru-Muna *et al.* (2007) observed increases in soil pH in plots amended with organic wastes. The high soil pH in the amended plots is attributed to high Ca, Mg and K associated with the rice-husk dust whose effect on the soil can be likened to that of lime (Lickaz 2002). Mbah *et al.* (2017) reported that soil pH increases following organic waste application. However, the most appreciable increase in soil pH was recorded in the plot that had 5tonha⁻¹ RHD and 2tonha⁻¹ NPK (6.27), representing about 56.59% increase from the control plot. Adediran *et al.*, (1999), strengthened by Ano and Asumugha (2000) reported better improvement in soil fertility properties when organic and mineral fertilizers are combined than the lone application of either of them. The result showed that pH remained slightly acidic following amendment. According to Mbah and Onweremadu (2009) organic wastes when used as soil amendment reduced soil acidity to levels required for crop production. Nnabude and Mbagwu (2001) observed that amendment of soil with unburnt and burnt rice mill wastes failed to completely eradicate acid in strongly acidic soils and they attributed this finding to the production of CO₂ and organic acids during organic matter decomposition.

The mean and interactive of RHD and NPK had significant effect ($P < 0.05$) on organic carbon, soil organic matter and total nitrogen. While there was significant increase in organic carbon and organic matter as a result of increased application of RHD as lone treatment, increased addition of NPK had negative relationship with both organic carbon and organic matter. The highest amount of organic carbon and organic matter (2.00% and 3.46% respectively) were recorded in plot that had 5tonha⁻¹ RHD and 3tonha⁻¹ NPK, while their least values were obtained in plot that had only 5tonha⁻¹ NPK. The observed rate of enhancement in soil organic carbon and organic matter could be attributed to the high content of organic carbon in the RHD as also observed by Nwaite *et al.*, (2019). This findings can be justified on the bases that while organic manures improve soil

biology and organics at sustainable levels (Awodun, 2007), mineral fertilizers use at consistent manner are known to destroy soil health especially soil organic matter (Awodun, 2007). The interaction between 5tonha⁻¹ RHD and 3tonha⁻¹ NPK generally had the best improvement on organic carbon and organic matter with about 80% increase when compared with the control plot. Similar reports on the effect of RHD on soil organic matter has been made by Njoku *et al.*, (2015) and Njoku and Mbah, (2012).

The changes in the soil pH and organic matter brought about by rice husk dust might have influenced the level of availability of phosphorus since the availability of phosphorus and its solubility is pH dependent. Application of RHD and NPK as single and combined treatments led to significant (P <0.05) increase in soil available phosphorus. The phosphorus values ranged from 4.72 mg/kg in the control plot to 25.14 mg/kg in the plot that had 5tonha⁻¹ RHD and 4tonha⁻¹ NPK showing an increase of 84.20%. Playing prominent role in this observation, is the high organic matter content in the RHD which reduced acidity through its lime function and by breaking down phosphorus fixation caused by the sesquioxide and certain soil minerals, thereby releasing the adsorbed phosphorus for plant uptake in phosphorus deficient soils (Gilbert, 2009; Cordell *et al.*, 2009).

Table 2. Mean effect of rice husk compost and NPK on soil chemical properties

RHD +NPK (t/ha)	pH H ₂ O	Aval. P CaCl ₂ (mg/kg)	Org. C (%)	Org. M (%)	Total N (%)	Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	TEA (Cmo1/kg)	ECEC	
Control	4.81	3.98	4.72	0.49	0.85	0.09	2.51	1.77	0.16	0.02	3.12	7.58
0 + 1	4.71	3.82	4.78	0.15	0.26	0.12	2.48	1.41	0.23	0.03	3.01	7.16
0 + 2	6.61	3.31	5.07	0.13	0.22	0.18	2.40	1.40	0.27	0.04	3.00	7.11
0 + 3	4.51	3.31	5.98	0.11	0.19	0.24	2.34	1.33	0.39	0.01	3.00	7.07
0 + 4	4.37	3.26	7.05	0.10	0.17	0.25	2.37	1.20	0.54	0.01	3.11	7.23
0 + 5	4.36	3.21	6.83	0.07	0.12	0.31	2.17	1.11	1.19	0.01	3.17	7.65
1 + 0	4.91	4.07	4.96	1.10	1.89	0.10	2.70	1.79	0.19	0.03	3.02	7.73
1 + 1	4.88	3.95	5.13	1.12	1.94	0.19	2.73	1.81	0.37	0.05	2.88	7.84
1 + 2	4.74	3.85	5.40	1.09	1.89	0.22	2.70	1.87	0.62	0.07	2.75	8.01
1 + 3	4.71	3.81	7.61	1.06	1.82	0.28	2.64	1.85	0.96	0.05	2.70	8.20
1 + 4	4.61	3.76	11.14	1.03	1.78	0.29	2.70	1.71	1.22	0.02	2.74	8.39
1 + 5	4.61	3.51	10.95	1.00	1.73	0.33	2.63	1.53	1.96	0.02	2.79	8.98
2 + 0	5.00	4.16	5.04	1.23	2.13	0.16	2.72	1.99	0.47	0.06	3.00	8.22
2 + 1	4.97	4.10	5.22	1.29	2.23	0.20	2.77	2.04	0.49	0.07	2.53	7.90
2 + 2	5.01	4.25	6.84	1.30	2.25	0.26	2.80	2.13	0.88	0.09	2.40	8.30
2 + 3	4.98	4.01	8.97	1.27	2.20	0.29	2.77	2.21	1.17	0.07	2.34	8.56
2 + 4	4.91	3.99	14.80	1.20	2.07	0.33	2.76	2.01	1.40	0.05	2.37	8.59
2 + 5	4.87	3.84	12.67	1.42	1.99	0.36	2.71	1.88	2.07	0.03	2.42	9.11
3 + 0	5.12	4.21	5.29	1.45	2.46	0.17	2.99	2.01	0.29	0.09	2.95	8.33
3 + 1	5.02	4.17	6.22	1.55	2.51	0.24	3.02	2.12	0.66	0.10	2.50	8.40
3 + 2	5.13	4.37	9.71	1.50	2.68	0.29	3.19	2.22	0.97	0.11	2.44	8.93
3 + 3	5.12	4.59	10.88	1.53	2.60	0.31	3.14	2.30	1.28	0.09	2.40	9.21
3 + 4	5.01	4.52	18.18	1.71	2.65	0.36	3.09	2.25	1.92	0.07	2.48	9.81
3 + 5	4.98	4.40	17.06	1.51	2.61	0.37	2.98	2.07	2.18	0.05	2.49	9.77
4 + 0	5.51	4.76	8.20	1.63	2.61	0.21	3.03	2.16	0.43	0.10	2.90	8.62
4 + 1	5.66	4.63	8.66	1.75	2.82	0.25	3.11	2.23	0.84	0.11	2.44	8.73
4 + 2	6.14	4.72	10.48	1.81	3.03	0.31	3.27	2.27	1.01	0.12	2.39	9.06
4 + 3	6.01	4.59	13.92	1.81	3.13	0.34	3.71	2.34	1.35	0.11	2.30	9.81
4 + 4	5.98	4.52	23.12	1.53	3.09	0.37	3.20	2.30	1.98	0.07	2.32	9.87
4 + 5	5.87	4.40	21.47	1.79	2.96	0.40	3.13	2.12	2.28	0.06	2.36	9.95
5 + 0	6.13	5.00	11.45	1.73	2.99	0.27	3.11	2.21	0.58	0.11	2.16	8.17
5 + 1	6.14	4.79	11.88	1.78	3.07	0.29	3.18	2.27	1.00	0.14	2.13	8.72
5 + 2	6.27	4.84	12.47	1.82	3.15	0.33	3.75	2.30	1.13	0.13	2.07	9.38
5 + 3	6.13	4.82	16.37	2.00	3.46	0.36	3.80	2.37	1.50	0.12	2.00	9.79

5 + 4	6.01	4.74	25.14	1.91	2.97	0.39	3.36	2.34	2.08	0.09	2.10	9.97
5 + 5	5.95	4.52	22.45	1.79	3.09	0.42	3.28	2.22	2.35	0.07	2.20	10.1
LSD(0.05)												
RHD	0.08	0.069	0.379	0.013	0.069	0.008	0.079	0.021	0.053	0.009	0.01	0.17
NPK	0.08	0.069	0.379	0.013	0.069	0.008	0.079	0.021	0.053	0.009	0.01	0.17
Interact	0.19	0.169	0.929	0.032	0.171	0.020	0.194	0.051S	0.731	0.021	0.025	1.02

As anticipated, nitrogen increased proportionately with treatments application both as lone and combined treatments. This observation can be related to the fact that both RHD and NPK are precursor to nitrogen supply. Nitrogen values ranged from 0.09% in control plot to 0.42 in plot that had 5tonha⁻¹ RHD and 3tonha⁻¹ NPK representing about 82.35% increase. The high organic matter in RHD and nitrogen associated with both materials could be responsible for the observed increase in total nitrogen which is in agreement with the observations of Suma *et al.*, (2017) who reported increased nitrogen when soils were amended with rice hull and rice straw.

Significant effect ($P < 0.05$) on exchangeable bases (Ca^+ , Mg^{++} , K^+ and Na^+) due RHD and NPK application both singly and interactively were observed. Apart from K^+ which increased with the lone application of NPK, all other cations slightly decreased increased application of NPK. The lone application of RHD on the other hand, consistently increased all the basic cations studied. With the exception of Na^+ which had its highest value (0.14 cmol/kg) in plot treated with 5tonha⁻¹ RHD and 1tonha⁻¹ NPK all other basic cations ((Ca^+ , Mg^{++} and K^+) recorded their highest values (3.80 cmol/kg, 2.37 cmol/kg and 1.50 cmol/kg respectively) in experimental plot treated with 5tonha⁻¹ RHD and 3tonha⁻¹ NPK.). Relative to control, the basic cations have increased by 60.22%, 57.25% and 90.36% for Ca^{++} , Mg^{++} and K^+ respectively in the plot treated with 5tonha⁻¹ RHD and 3tonha⁻¹ NPK, while Na^+ was increased by 87.50% in the plot that had 5tonha⁻¹ RHD and 1tonha⁻¹ NPK . The high basic cation content of RHD earlier observed in this study must have influenced the result. Rice husk dust being an organic material contains large amount of organic matter which when decomposed is able to release differs basic cations to the soil (Brady and Weil, 2008). There are also reports of increased basic cations in the soil and reduction in soil acidity due to rice husk dust application (Aadu and Akamigbo, 1990; Njoku and Mbah, 2012)

The total exchangeable acidity (TEA) and the Effective Cation Exchange Capacity were significantly improved by the application of RHD and NPK. While there was significant increase in ECEC due to the addition of the experimental materials, there was sharp decrease in the concentration of TEA due to the interactive effect of RHD and NPK and the lone application of RHD. Relative to control, there was a decrease of about 40.23% in TEA and an increase of 57.13% in ECEC, due to the amendments. Using burnt and unburnt rice husk dust, Njoku and Mbah (2012), reported a decrease in TEA and an increase in ECEC relative to non-rice husk treated soils. According to Adeleye *et al.* (2010), the application of organic amendment increased soil exchangeable Mg, Ca, K, and Na, and lowered exchangeable acidity. Other studies have reported the role of organic waste materials in soil buffering, cations release, pH moderation, phosphorus release, reduction in TEA and increase in CEC (Mbagwu *et al.*, 1991, Owolabi *et al.*, 2003 and Azu *et al.*, 2017).

EFFECT OF RHD AND NPK ON GROWTH PARAMETERS OF JATROPHA

Number of Branches and Plant Height:

Jatropha, being a perennial plant, displays vigorous growth within the first few years of planting and plant height and number of branches among other factors are key parameters for the estimation of the growth rate (Kabir *et al.*, 2009). Plant height and number of branches were measured at 6 months after planting and the average height and number of branches is shown in figure 1. Results showed significant influence of both materials on plant height and number of branches compared with the control treatment. This observation corroborates with the findings of Oliver, (2016), who reported increased growth rate of Jatropha cultivated in soils amended with organic and inorganic fertilizers. Nwaite *et al.*, (2019), earlier reported high nutrient content especially, nitrogen, silicon and phosphorus in rice husk dust which enhanced the growth of plants. Study conducted by Karaj and Muller (2010) revealed a linear relationship between nitrogen and plant height. These justifies the findings of this present study. Plant height and number of branches variations were highly significant among the different rates of RHD and NPK application at the period of measurement. These parameters had increased proportionally with the rates of amendments and the maximum number of branches and plant heights (24.33 and 232.7 cm) were recorded in the plot treated with 5tonha⁻¹ RHD and 3tonha⁻¹ NPK. This in relation to control represents about 78.48% and 84.10% increase in number of branches and plant height respectively. Henning, (2007) stated that even though Jatropha is adapted to marginal soils with low nutrient content, in order to support high biomass and production, it demands fertilization and can consume a marginal level of fertilizer. The probable reason for these observations could be due to increased nutrients release especially nitrogen from both amendments that promotes vegetative growth of plants (Brady and Weil, 2008). This shows the importance of nitrogen for the growth of the plant, which is in agreement with the report of Tisdale *et al.* (2003) who showed that N is necessary for most physiological growth processes, and its absence or deficiency causes stunted growth. Owolabi *et al.*, (2016) in their study also observed significant effect organic and inorganic fertilizers on the growth and dry matter yield of Jatropha. These findings are also in accordance with the work of Suma *et al.*, (2017), who reported a striking increase in the nitrogen content and growth parameters of rice which were amended with rice husk hull. Also, Njoku and Mbah, (2012) and Njoku *et al.*, (2015) reported increased maize performance due to rice husk dust application.

Number of Leaves and Stem Girth

As expected, the number of leaves and stem girth were improved due to RHD and NPK addition relative to the control experiment (Fig 2). These parameters were significantly ($P < 0.05$) affected by the application of RHD and NPK at 6 months of growth. Relative to control, the number of leaves and stem girth had increased by 80.55% and 66.51% respectively due the addition of RHD and NPK. These results correspond to increased nutrient release by the treatments especially nitrogen which plays major role in vegetative growth of plants (Brady and Weil, 2008). The application of 5 ton ha⁻¹ RHD and 5 ton ha⁻¹ resulted in highest number of leaves and stem girth. This shows that Jatropha response positively with increased nutrient addition. This agrees with the report of Oliver, (2016), who observed increased number of leaves of Jatropha due to increased rates of organic and inorganic fertilizer addition. Zero fertilizer application (Control) gave the lowest values, as they had to rely on the native soil fertility, which, from the result of chemical analysis, was below the critical values especially in nitrogen. In correlation with the results of this study, Nafiu *et al.* (2011) reported that all treated plants performed better than the control in terms of growth of egg plants.

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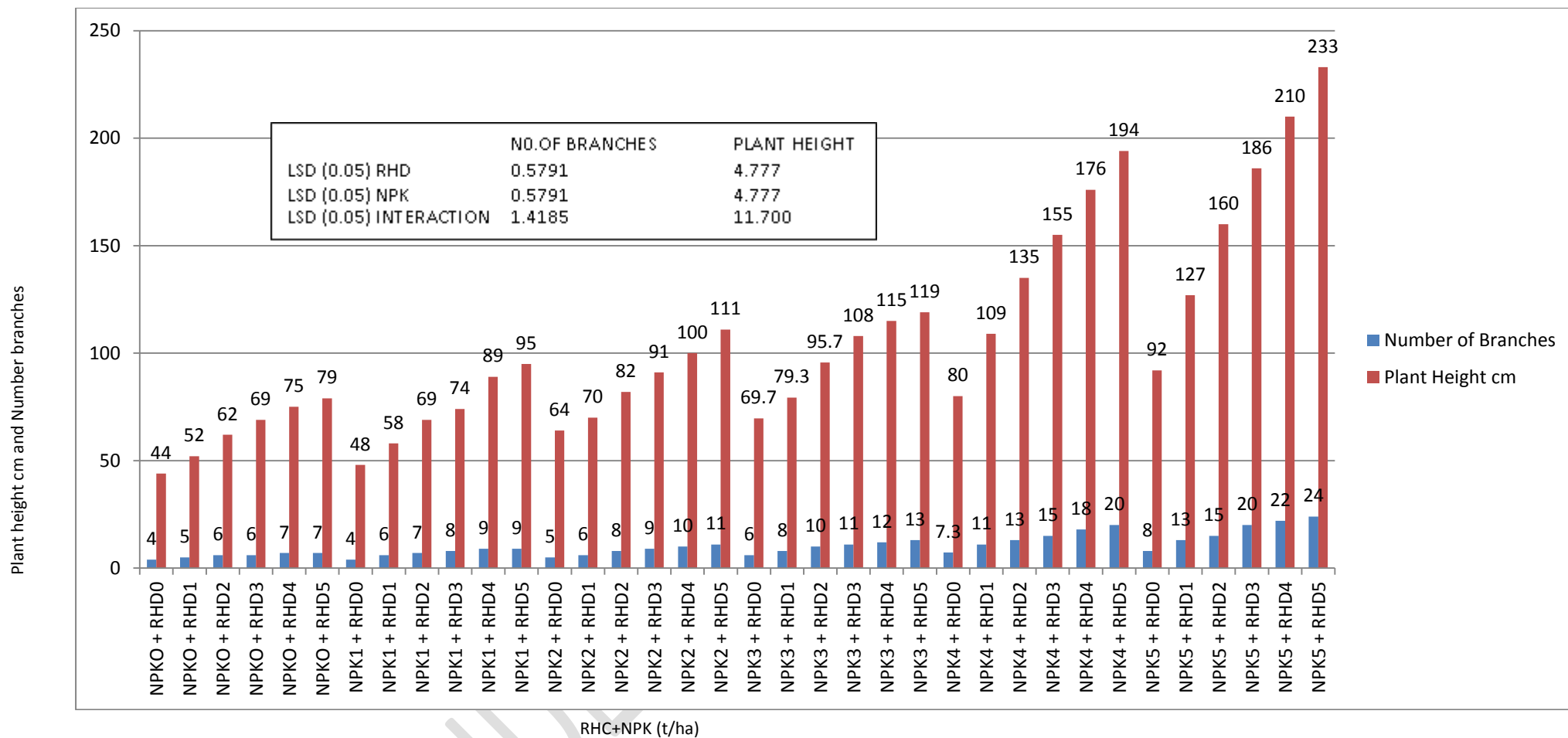


Fig1. Mean effect of rice husk dust and NPK fertilizer on plant height and number of branches

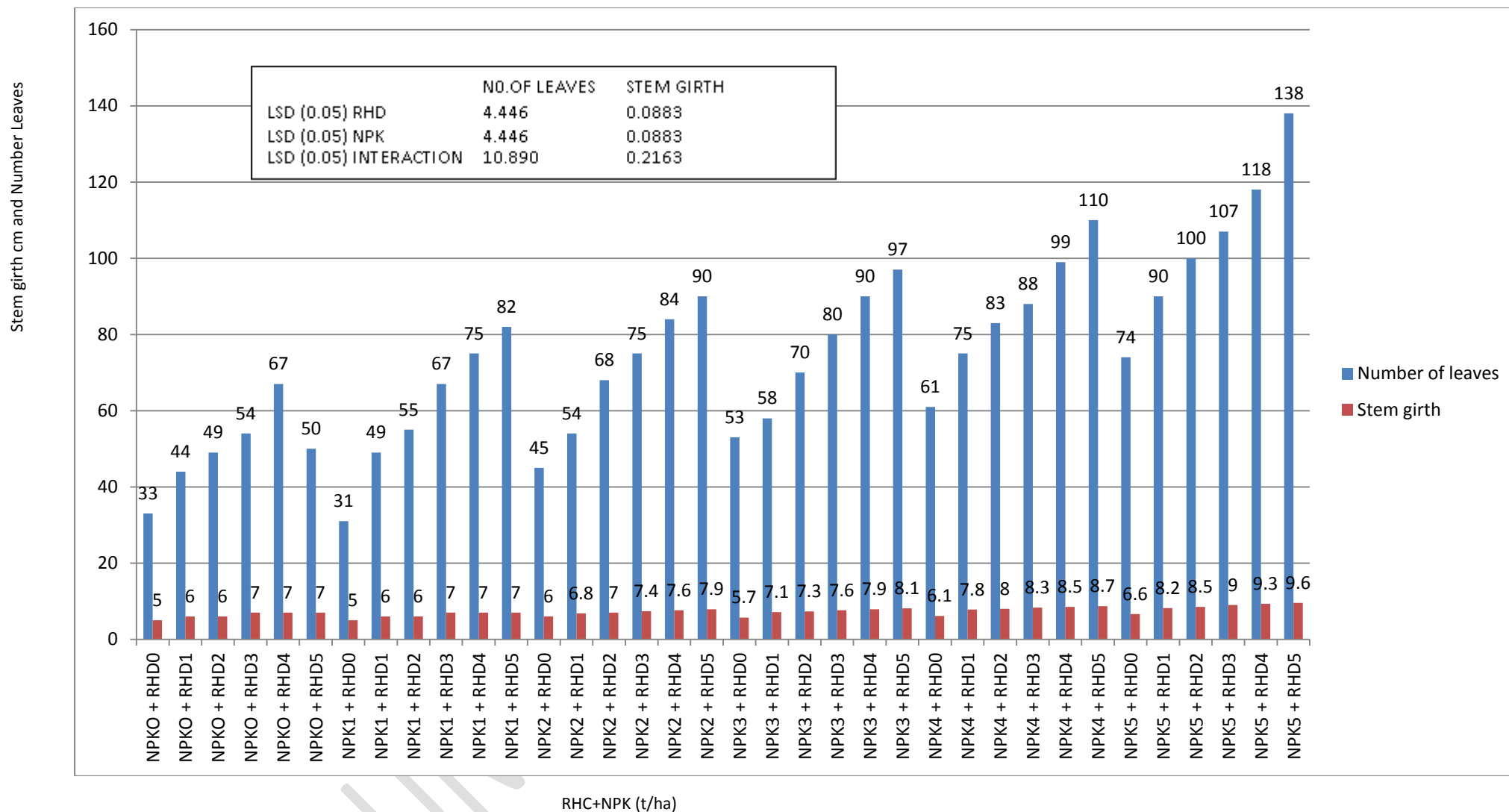


Fig2. Mean effect of rice husk dust and NPK fertilizer on number of leaves and stem girth

Conclusion

Soil fertility properties and growth response of *Jatropha curcas* produced in soil treated with different levels of rice husk dust and NPK was investigated in this study. This study showed that RHD and NPK application had significant effect on soil properties and growth of *Jatropha curcas*, as the least values of the measured soil fertility properties and growth parameters were obtained in the control experiment with no fertilizer application at the period of evaluation with the highest rate of manure application resulting in significantly higher values of the measured parameters. From the observed results of this study, 5tons ha⁻¹ RHD and 5ton ha⁻¹NPK could be considered optimum for the soil fertility properties and growth of *Jatropha curcas* in southeastern Nigeria and is therefore recommended.

References

- Adeiran, J. A., Akande, M. O., Taswo, L. B., and Sobulo, R. A. (1999). Comparative effectiveness of organic based fertilizer with mineral fertilizers on crop yield. In: Management of the soil resources for sustainable agricultural production in the 21st century, proceedings of the 25th conference of the soil science society of Nigeria (SSSN), Benin City. Pp 91-93.
- Adeleye EO, Ayeni LS, Ojeniyi SO. (2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on alfisol in southwestern Nigeria. *J. Am. Sci.* 6(10):956–959.
- Ano, A. O. and Asumugha, G. N. (2000). On-farm testing of sustainable management technology for cassava production on ultisol in Southeastern Nigeria. Paper Presented at 34th Annual conference of Agricultural Society of Nigeria, Bauchi.
- Aransiola, E.F., Daramola, M.O., Ojumu, T.V., Aremu, M.O., Layokun, S.K and Solomon, B.O.(2012).Nigerian *Jatropha Curcas* Oil Seeds: Prospect for Biofuel Production in Nigeria. *International Journal of Renewable Energy Resaerch.*2(2):316-325.
- Asadu CLA, Akamigbo FOR. (1990). Relative contribution of organic matter and clay fraction to cation exchange capacity (CEC) in soils in south eastern Nigeria. *Samaru J. Agric. Res.*2:17–23.
- Awodun MA, Otani MS, Ojeniyi SO.(2007). Effect of sawdust ash plus urea on maize performance and nutrient status. *Asain J. Agric. Res.* 12:27-30.
- Azu, Donatus E.O, B.A. Essien and Ikpe Juliana Nneka (2017).Comparative Effect of Rice Husk Compost and Urea on Soil Chemical Properties, Growth and Yield of Fluted Pumpkin (*Telfairia Occidentalis*) in Akanu Ibiam Federal Polytechnic, Unwana, Afikpo, Ebonyi, State, Nigeria. *Int. Journal of Science and Technoledge, Vol. 5, Issue, 1, pp.15-20.*
- Benton, Jones J. Jr. (2001). Laboratory Guide for Conducting soil test and plant analysis. CRC Press Boca Raton, Washington DC.
- Brady, N.C. and Weil, R.R. (2008). The Nature and properties of soil. 12th edn, prentice Hall Inc. New Jersey.
- Carter, M.R. and Gregorich, E.G.(2008).Soil sampling and methods of analysis. 2nd (ed). *Can. Soc. Soil Sci.pp.1224.*
- Condron. LM. Moir, J.O Tiessen, H and Stewart J.W.B (2005) critical evaluaton of methods for determining of total organic P in tropical soils. *Soil scie soc. AM.J.* 54: 1261-1266
- Cordell, D., Drangert, J. O. and White, S. (2009). The story of phosphorus: global food security and food for thought. *Glob. Environ. Change*, 19:292-305.
- Demirbas A. (2009) "Production of biodiesel from algae oils," *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, vol. 31, (no. 2), pp. 163-168,
- Federal Department of Agriculture and Land Resources (1985). Soil Map of Nigeria project. Pp63-148.
- Ganihreh, Y.K., Wassmann, R. and Vilegas-Panga, G. (2013). Impact of elevated temperatures on greenhouse gas emmission in rice systems: Interaction with straw incorporated studied in a growth chamber experiment. *Plant Soil* 373: 857 - 875
- Gilbert N. (2009) Environment: the disappearing nutrient. *Nature* 461: 716–718
- Henning, R. (2007), *Jatropha curcas* L. International Energy Agency 2006, World Energy Outlook, IEA, Paris.
- Horn, M. (2014), "OPEC's optimal crude oil price," *Energy Policy*, vol. 32, (no. 2), pp. 269-280.

- Khan, J A.K.(2002) "Research into biodiesel kinetics and catalyst development,"The University of Queensland, Department of Chemical Engineering, vol. 17.
- Lateef, F.A., Onukwuli, O.D., Okoro, U.C., Ejikeme, P.M. and Jere, P. (2014). Some physical properties and oxidative stability of Biodiesel produced from oil seed crops. *Korean Journal of Chemical Engineering*, DOI: 10.1007/s11814-014-0028. Pp 1-7.
- Lickaz J (2002) Wood ash—an alternative liming material for agricultural soils. Agri-Facts, practical information for Alberta's agriculture industry. AGDEX 534-2, Alberta Agriculture, Food and Rural Development, p 6
- Mansaray, K.G. et al., (2007). Physical and Thermochemical properties Rice Husk. *Journal of Asian Ceramic Societies* 6(4):31-40
- Mbagwu JSC, Piccolo A, Spallaci P. (1991). Effects of field application of organic wastes from different sources on chemical, reological and structural properties of Italian surface soils. *Bioresource Technol.* 37:71–78.
- Mbah CN, Njoku C, Okolo CC, Attoe E, Osakwe UC (2017) Amelioration of a degraded Ultisol with hardwood biochar: effects on soil physico-chemical properties and yield of cucumber (*Cucumis sativus* L). *Afr J Agric Res* 12(21):1781–1792.
- Mbah CN, Onweremadu EU. (2009). Effect of organic and mineral fertilizer inputs on soil and maize grain yield in an acid ultisol in Abakaliki, southeastern Nigeria. *American-Eurasian J. Agron.* 2(1):7–12.
- Nafiu, A. K., Togun, O., Abiodun, M. O. and Chude, V. O. (2011), "Effects of NPK fertilizer on growth, dry matter production and yield of eggplant in South Western Nigeria", *Agriculture and Biology Journal of North America*.
- Njoku C, Mbah CN, Okonkwo CI. (2011). Effect of rice mill wastes application on selected soil physical properties and maize yield (*Zea mays* L.) on an ultisol in Abakaliki, southeastern Nigeria. *J. Soil Sci. Environ. Manage.* 2(11):375–383.
- Njoku, C., and Mbah, C.N. (2012). Effect of burnt and unburnt rice husk dust on maize yield and soil physico-chemical properties of an ultisol in Nigeria. *Biological Agriculture and Horticulture*, 28 : 1. 49 – 60.
- Njoku, C., Uguru, B.N. and Mba, C.N. (2015). Effect of Rice Husk Dust on selected Soil Chemical Properties and Maize Grain Yield in Abakaliki, South Eastern Nigeria. *Applied Science Report*, 12(3)143-149.
- Njoku, J.C., Okpara. D.A and Asiegbu, J.E. (2006). Growth and yield response of Sweet potato to inorganic Nitrogen and potassium in a tropical ultisol. *Nig. Agric. J.* 32:30-41.
- NN
- Nnabude PC, Mbagwu JSC. (1998). Soil water relation of Nigeria typic haplustult amended with fresh and burnt rice mill wastes. *Soil Tillage Res.* 50:207–214.
- Nwagbara, M.O. (2007). Temperature characteristics and variability over cities in southeastern Nigeria (1965 – 1994). M.Sc thesis, Department of Geography, University of Port-Harcourt.
- Nwaogu. E.N. and Ebeuro. C.N. (2009). Greenhouse evaluation of the performance of turmeric grown on soils of different parent materials in southeastern Nigeria. *ASN 43th Annual Conference. Proc.* 864.
- Nwite, J.C., Unagwu, B.O. and Okolo, C.C. (2019). Improving soil silicon and selected fertility status for rice production through rice-mill waste application in lowland sawah field of southeastern Nigeria. *Int. J. Recycl. Org. Waste Agricul.* 8, 5271 – 5279
- Oliver, E. N. (2016). Effect of organic and inorganic fertilizers on the growth and yield of physic nut (*Jatropha Curcas*). *Int. J. of Advances in Agriculture and Environment Eng.* 3(1):131- 135
- Osueke, C.O. and Ezugwu, C.A.K. (2011). Study of Nigerian Energy Resource and utilization. *International Journal of Scientific and Engineering Research*, 2(12):1-9.
- Owolabi O, Adeleye A, Oladeje BT, Ojienyi SO. (2003). Effect of wood ash on soil fertility and crop yield in southwest Nigeria. *Nigerian J. Soil Sci.* 13:55–60.
- Owolabi, I.O.; Ashaolu, J.T.; and Abayomi, Y.A. (2016). Effect of inorganic and fertilizer application on plant growth and dry matter yield of Physic nut (*Jatropha curcas* L.). *International Journal of Agriculture and Food Research* 5(1):14-21.
- Pansu, M. and Gautheyrou, J. (2006). *Handbook of Soil Analysis: Mineralogical Organic and Inorganic Methods*. Springer, p995.
- Paul, B. Okon et al., (2007). Effect of rice husk ash and phosphorus on some properties of acid sands and yield of okra. *Communication in Soil Science and Plant Analysis*. 36(7-8):
- Simmons, E. N., Jones, J. B., Mills, A. H., Smittle, A. A. and Hussey, C. G. (1994). Comparison of analytical methods for nitrogen analysis in plant tissues. *Common Soil Science*, 24:1609-1616.
- Suma, A., Khan, H.R and Hossain, M, S. (2017) Effect of rice hull, rice straw and saw dust application on primary nutrient of rice growth under variable moisture conditions in saline soil, *Bangladesh J. Sci. Res.* 30(1& 2):11 -21.
- Udo, E.J., Ibia, T.O., Ogunwale, J.A., Ano, A.O. and Esu, I.E. (2009). *Manual of soil, plant and water analysis*. Sibon Books Ltd, Lagos, Nigeria, pp 17-33.

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