Original Research Article

The Effect of Charcoal and NPK Fertilizer on the Growth of two Peppers varieties on the sandy loamy soil in Sinyea, country?

Abstract

This research shows the effect of ~~charcoal + NPK fertilizer (~~combination of charcoal and NPK Fertilizer~~)~~ on the growth of two pepper (*Capsicum annum* L.) varieties. The treatment levels were: control (no treatment), charcoal (450 g plot^{-1}), NPK (112.5 g plot^{-1}) and ~~charcoal + NPK~~ combination of 450 g plot^{-1} charcoal and 112.5 g plot^{-1} NPK) . The experimental plots were 32 in total with 1.5 squares meter each. The growth parameters considered were: plant height, number of leaves, number of branches, leaves length, leaves width and plant diameter. The data analyzed indicated that Local pepper performed better than Jalapeno pepper for all treatments. For plant height charcoal plots performed better than control with these means 28 cm, 64 cm and 72 cm for date 1, 2, and 3 respectively. The Local pepper performed better than Jalapeno in growth with these plant height means 31 cm, 86 cm, and 96 cm for date 1, 2, and 3 respectively. Bigger stem diameters were recorded for the Local pepper and even wider leaf. The Local pepper performed better than the Jalapeno pepper at all levels of growth.

Key words: *Charcoal, NPK fertilizer, Growth and Pepper*.

1: Introduction

The name pepper is widely known almost everywhere as spoken in English language. Pepper which scientific name *Capsicum annum* belonging to the family of Nightshade, which is a spicy and pungent vegetable. It is a flowering plant and a horticultural crop grown in backyard gardens. The spicy and pungent horticultural crop, pepper, history can be traced far back from 7500BC from the west particularly Southern America, where it was eaten as food. The crop was introduced into Europe by an explorer Christopher Columbus upon his returned from America and later spread to Asia and Africa. Before this crop was brought to Europe, a black pepper was used by Europeans as currency or medium of exchange. The cultivars of this crop vary according to the quantity of capsaicin present in it or how pungent is the crop. The capsaicin is the chemical compound that produces the burning and is mordacious to mammals not birds. Birds swallow this crop without feeling the burns but it react faster to mammals upon consumption. In regard to the varieties, some have less capsaicin like Belle and Jalapeno peppers while others have enough capsaicin that produces burns or pungent. The used of organic fertilizers for crop production have been traced far back from primitive farming activities to modern farming to essentially develop plants. The organic materials served as a host for microorganisms that

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provide nutrients to soil for plants uptake (Silva, Ranil and Fonseka, 2012). The economic values of organic manures have provided crops with essential NPK content, which is capable to enhance soil fertility. On the other hand, organic materials served as substrate for microorganisms which lead to an increase in microbial activity. Organic fertilizers significantly increase the soil carbon, nitrogen, pH, cation exchange capacity (CAC), and exchangeable calcium, magnesium and potassium which invariable enhance crop yield and productivity. Vesicular arbuscular mycorrhizal fungi (VAM) are widespread soil fungi that are capable of enhancing yield of several agricultural crops (Thanuji, 2002). They are important in ecological agriculture because of its benefits provided to majority of cultivars and the conservation of the environment by acting as bio-fertilizers, biological protectors and biological control agents (Azcon-Aguilar, Jaizme-Vega and Calvet, 2002). The difficulties faced by smallholder farmers are compounded by inadequate use of agricultural inputs to replenish the lost nutrients. This inadequate has been caused by shortage of capital and lack of access to credit facilities to enhance the purchasing of farm inputs and has hampered the use of inorganic fertilizers. The local economic policies and the slow global economy improvement have led to higher fertilizers prices. The result is expensive fertilizers which is contributing to low quantity fertilizer applications. The lower or no fertilizer application is contributing to poor crop productivities. This situation is made worse by continuous cropping without returning the plant residues back into the field (Heerink, 2005). Soil fertility depletion remains the major factor causing decline in crop productivity on smallholder farms. The infertility has resulted in low returns of agricultural investments, declining food security and higher prices of foods. Study has indicated that soil infertility is one of the results of soil erosion, removal of crop residues, access rain fall and continuous cultivation (Opala, Okalebo, Othieno and Kisinjo, 2009). The horticultural crop productions in Africa are given serious alarm since malnutrition continues to strike the continent. The lack of balance diet is contributing to poor growth and mental incapability to the growing population. In order to tackle this situation in the evergreen continent of Africa, adequate attention is to be given to agricultural productivities for improvement of livelihoods and food security.

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What are the reasons of using charcoal as fertilizer? Give some references on the use of charcoal as fertilizer with the rates used and some results.

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2. Methodology

Study Setting and Duration

The research was conducted on Cuttington University Agricultural Students Research site in a sandy loamy soil of Sinyea Township, Bong County, Liberia. The period covered by this research was from March 22, 2014 to October 10, 2014.

~~**Research Population**~~ **Experimental design**

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The Complete Randomize Block Design Method, CRBDM with four (4) replications, was used. The treatment structure is a combination of four levels of fertilizer [(1) control/no treatment; (2) (450 g charcoal plot^{-1}; (3) 112.5 g NPK plot^{-1}); and (4) combination of 450 g plot^{-1} charcoal and 112.5 g plot^{-1} NPK] and two pepper varieties (V1: Local pepper (From Suakoko, Liberia) and V2: Jalapeno pepper (From North Carolina, USA). The total experimental plots were 32, with a plot size of 1.5 m x 1.5 m. The plant population was 288 plants planted in the field with spacing of 60 cm x 60 cm. Each plot contains 9 plants, 3 x 3 in row and column. The total of 16 plots was assigned local pepper variety while 16 plots were also assigned the foreign pepper variety,

Jalapeno. The following treatments were observed: control plots were 8, charcoal plots were 8, fertilizer (NPK) plots were 8 while charcoal with fertilizer plots were 8. The application rates were 450 g/plot and 112.5 g/plot of charcoal and NPK fertilizer respectively.

Management practices

How the planting has been done? Was it direct planting of seeds or a nursery to have seedlings to be replanted?

When and how the fertilizer has been applied?

Sampling Techniques

A total of 3 (three) plants was randomly selected from each plot summing up to 96 plants considered for data collection.

Varieties and Fertility levels

Varieties:

- V1 = Local pepper (From Suakoko, Liberia)
- V2 = Jalapeno pepper (From North Carolina, USA)

~~Level of Fertilities~~

- ~~C1 = Control (No Charcoal)~~
- ~~C2 = Charcoal (2 tons/ha)~~
- ~~F1= Control (No Fertilizer)~~
- ~~F2 = Fertilizer (150 g/ha)~~

Methods of data collection

Among the 9 plants in every plot, 3 plants were randomly selected for data collection. The plants selected for data collection were marked in every plot as plant 1 to plant 3 for continuation of data collection. This was done to remember plants selected for accurate data collection. The growth parameters considered for data collection were: plant height, number of branches, number of leaves, leaf width, stem diameter, and leaf length. The data were collected for three consecutive months.

Data Analysis

State which data analysis procedure has been used.

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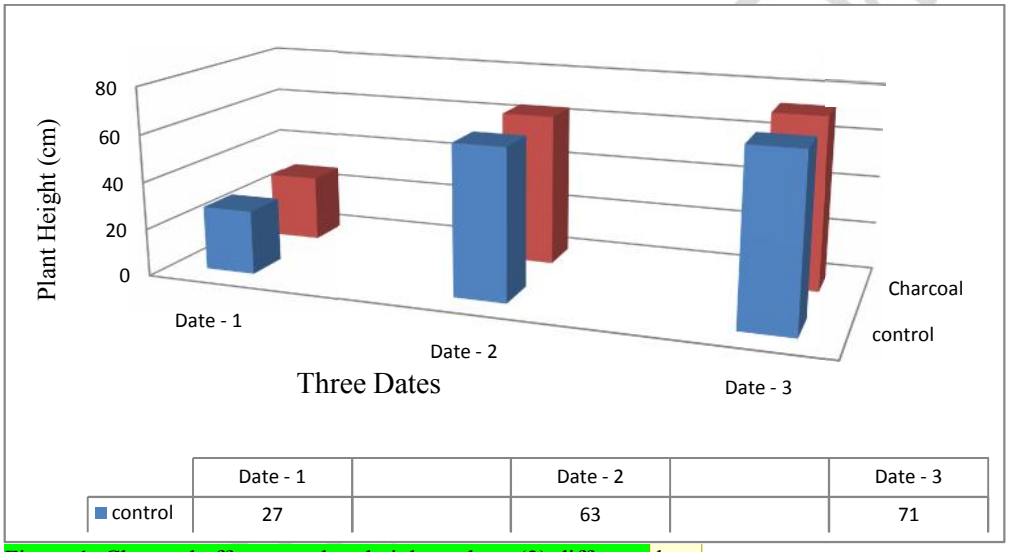
3. Results and Discussions

3.1: Data Presentation and Analysis



	Date - 1		Date - 2		Date - 3
control	27		63		71

Figure 1: Charcoal effects on plant height at three (3) different dates

Fig.1 showed the data results for the effects of charcoal on plant height at the three months of data collections. For the first month which is recorded as date 1, charcoal applied plots had the tallest plant height mean of 28 cm while the control plots had plant height mean of 27 cm. Date 2 showed that charcoal applied plots also performed better than the control with a mean plant height of 64 cm tall while control had 63 cm as mean plant height. The third date data showed that charcoal also had the tallest plant height mean of 72 cm over the control plot with 71 cm as plant height mean. The results indicated that the charcoal had better influence on the growth of the plant. The tallest plant height mean was observed in charcoal plots regarded of the variety of pepper. This result consented with a research conducted by Vantsis and Bond (1950) which concluded that wood charcoal increased plant dry weight and nitrogen fixation.

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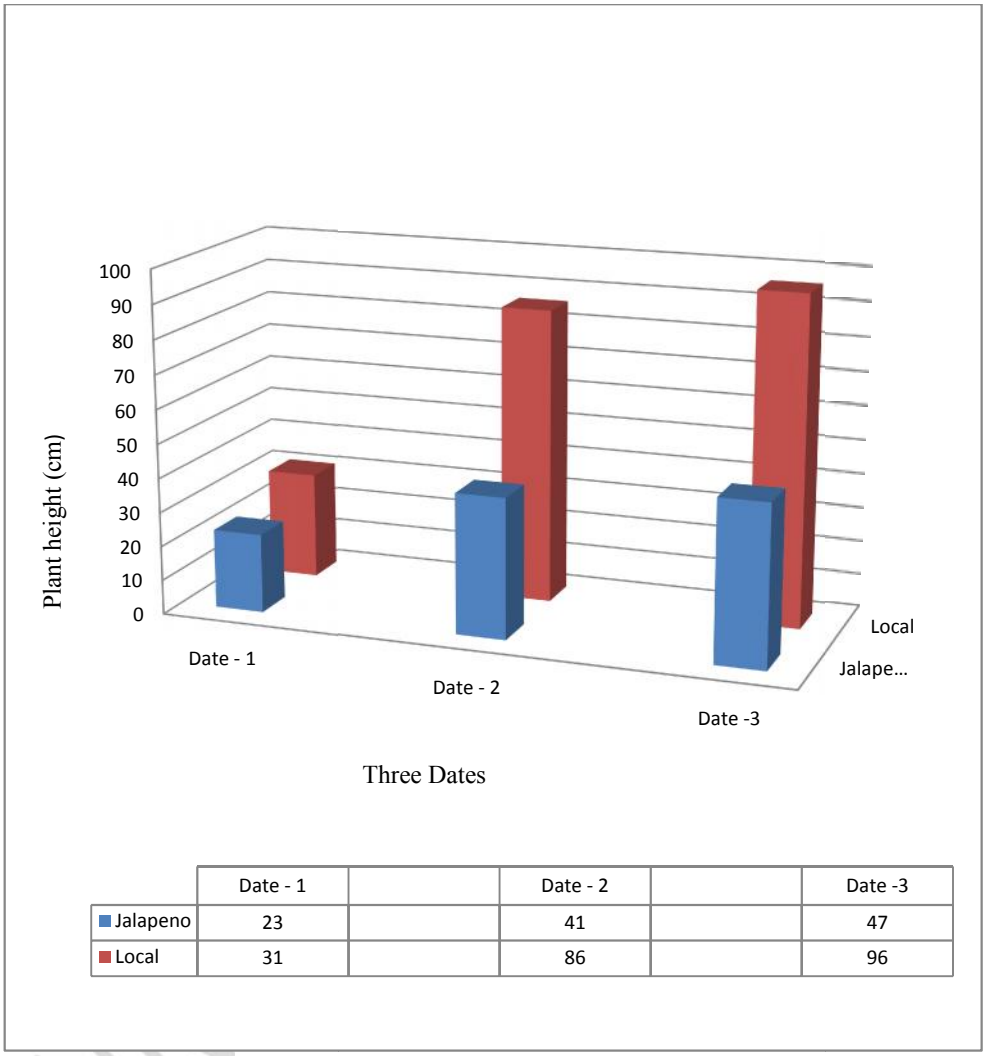
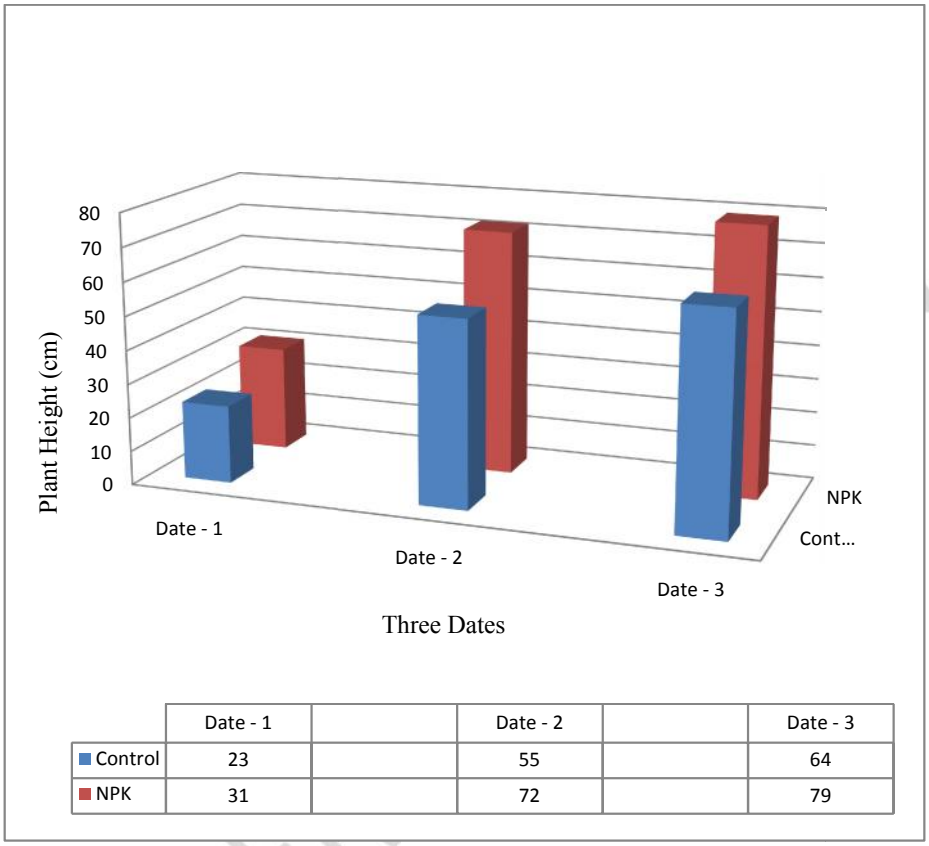


	Date - 1		Date - 2		Date -3
Jalapeno	23		41		47
Local	31		86		96

Figure 2: Plant Height of two pepper varieties at three dates

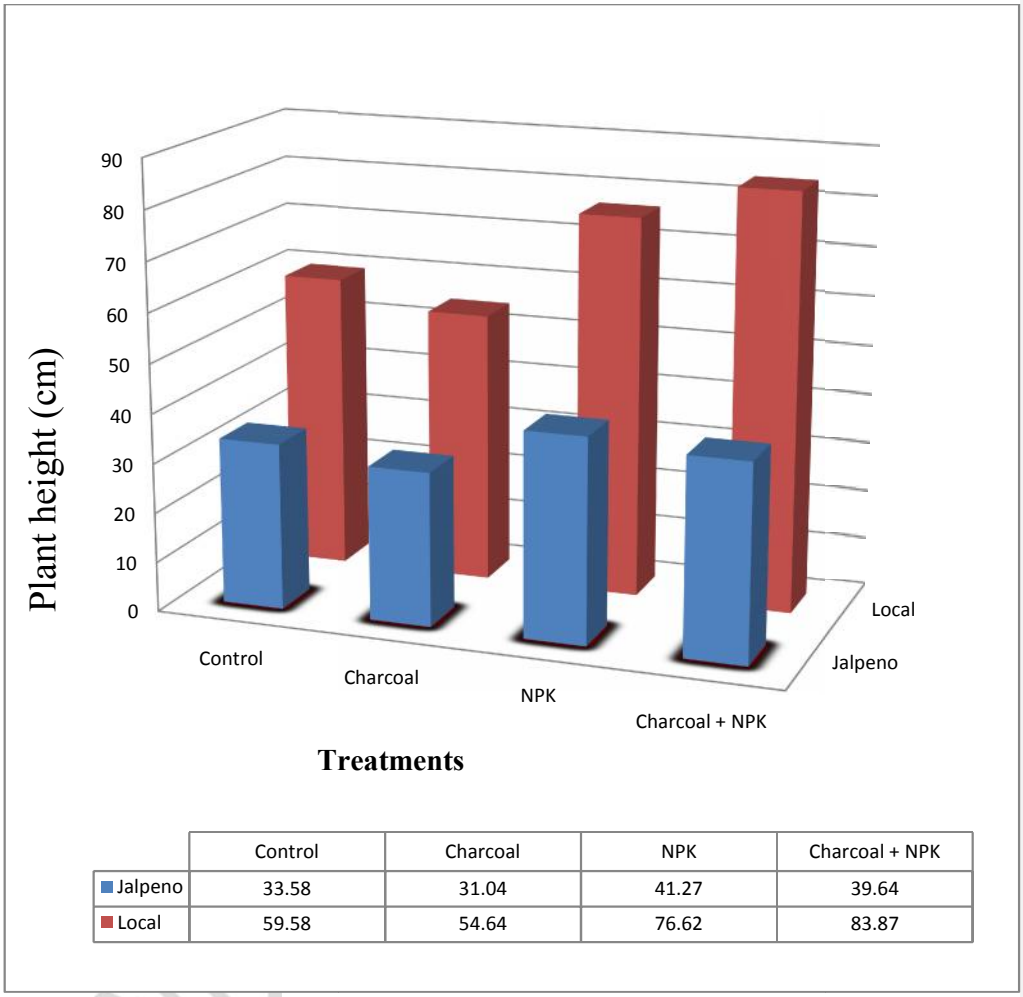
Fig. 2 revealed the plant height of two pepper varieties at three dates of data collection. Date one showed that the Local pepper had taller plant height mean than the Jalapeno with 31 cm while the Jalapeno pepper height mean was 23 cm. Date two data showed that the Local pepper also had taller plant height mean of 86 cm and the Jalapeno plant height mean was 41 cm. For date three, the Local pepper performed again better than the Jalapeno with the plant height mean of 96 cm while the Jalapeno plant height mean was 47 cm. The results showed that Local pepper performed better than the Jalapeno pepper in their growth analysis. The three months data clearly indicated the vigorous growth of the local pepper while the Jalapeno was struggling for survival.



	Date - 1		Date - 2		Date - 3
Control	23		55		64
NPK	31		72		79

Figure 3: NPK Fertilizer Effects on Pepper Plant Height at three dates

Fig. 3 showed the NPK fertilizer effects on pepper plant height at three dates. Date one showed that NPK fertilizer applied plots had taller plant height mean of 31 cm while the Control plots had shorter plant with a mean of 23 cm. For date two, the NPK fertilizer also had taller plant height mean of 72 cm compared to the Control plot with 55 cm as plant height mean. Date three also showed that NPK fertilizer plots were superior in height than the Control plots with 79 cm and 64 cm as plant height means respectively. The comparison of NPK fertilizer to Control clearly showed that NPK is superior and performed better than the control. From all data collected for the three months, it is very good in boosting plant growth. A research conducted by Kumar and Yadav (2008) revealed that NPK fertilizer applied at higher doses maintain soil fertility and raised crop growth and yields compare to N applied alone. Another research conducted by Omotoso and Shitu (2007) disclosed that the application of NPK fertilizer on Okra at the rate of 150 kg/ha and the ring method of application increased growth parameters.



	Control	Charcoal	NPK	Charcoal + NPK
Jalpeno	33.58	31.04	41.27	39.64
Local	59.58	54.64	76.62	83.87

Figure 4: four treatments effect on plant height

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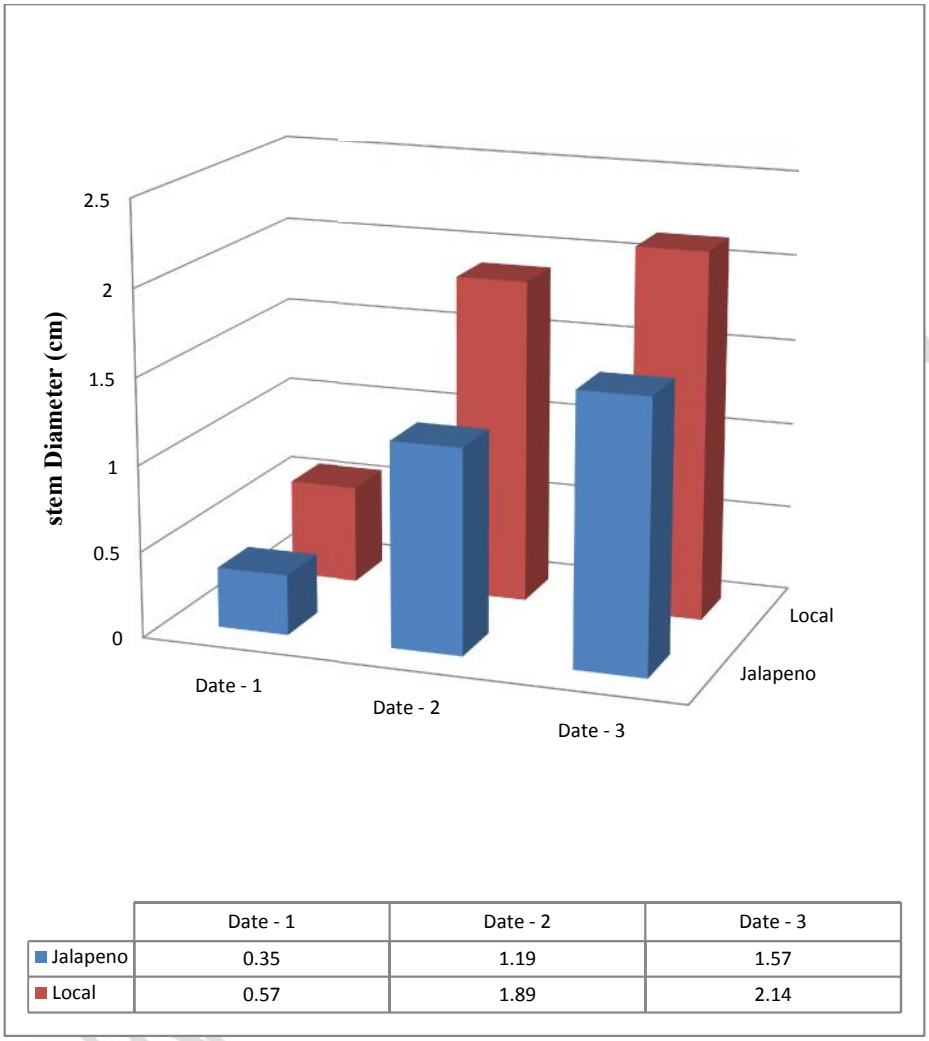
Fig.4 showed that Local pepper performed better than the Jalapeno pepper for the four treatments applied. For the Local pepper, Charcoal + NPK had the highest plant height mean of 83.87 cm followed by the charcoal plots mean of 76.62 cm. Unexpectedly the control plots performed better than the charcoal plots for the same Local pepper with means of 59.58 cm and 54.64 cm respectively. For the case of the Jalapeno pepper also, NPK plots had the highest plant height mean of 41.27 cm while the charcoal + NPK had a mean of 39.64 cm. The charcoal plots had higher mean than the control plots of 31.64 cm and 33.58 cm respectively. The improvement of plant growth was greatly seen when charcoal was combined with NPK fertilizer. This showed that charcoal improves crop growth as stated by McCormack, Ostle, Bardgett, Hopkins and Vanbergen (2013) in their research conducted on Biochar in bioenergy cropping systems.



	Date - 1	Date - 2	Date - 3
Jalapeno	0.35	1.19	1.57
Local	0.57	1.89	2.14

Figure 5: Effect of charcoal + NPK on stem diameter of two pepper varieties on three dates

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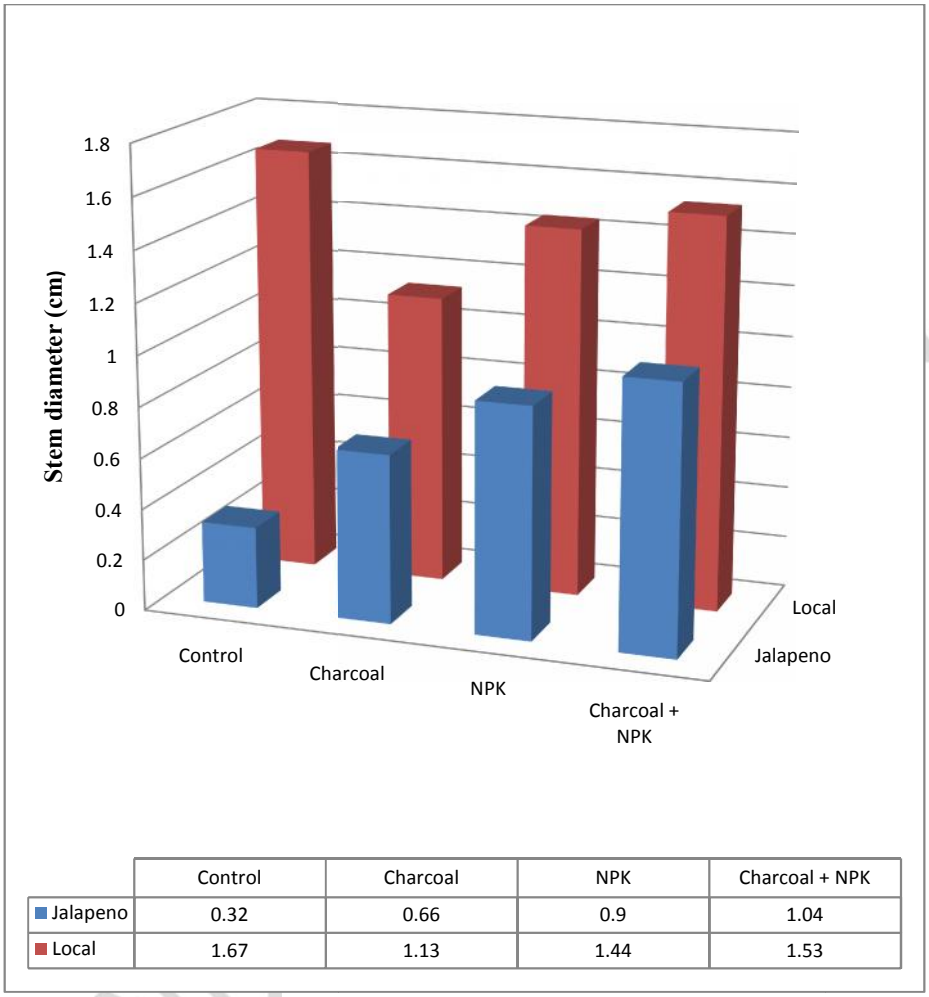
Figure 5 revealed the stem diameters for the two pepper varieties on three different dates. From the data analyzed, the Local pepper had larger stems means than the Jalapeno pepper for the three dates. The local pepper had 0.57 cm, 1.89 cm and 2.14 cm as means for the three dates respectively. The Jalapeno pepper had 0.35 cm, 1.19 cm and 1.57 cm as mean stem diameter for the three dates respectively.



	Control	Charcoal	NPK	Charcoal + NPK
Jalapeno	0.32	0.66	0.9	1.04
Local	1.67	1.13	1.44	1.53

Figure 6: Four treatments effects on the pepper stems

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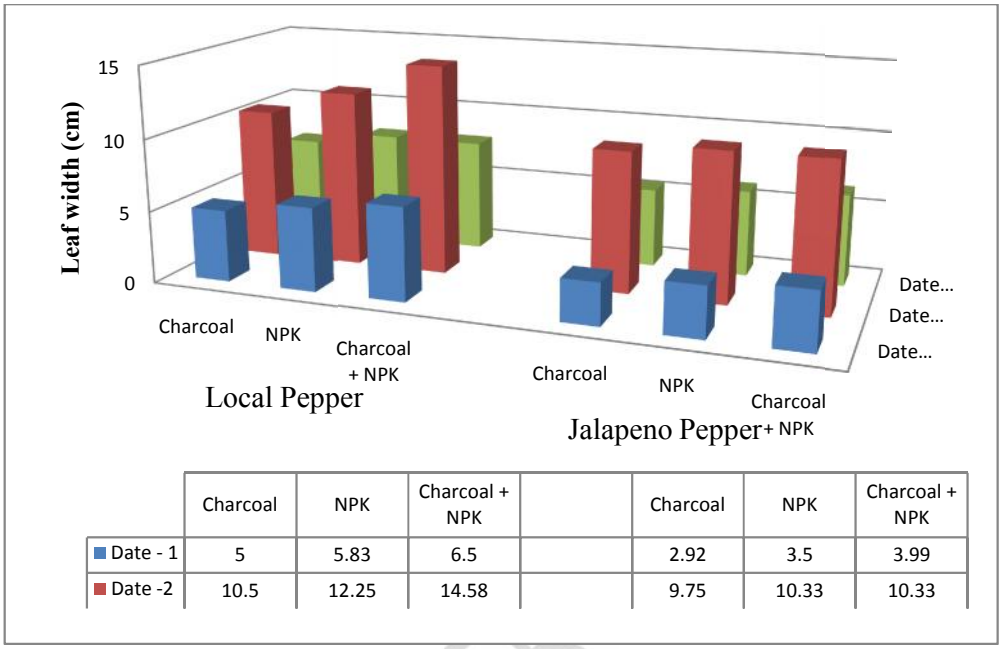
Figure 6 showed the four treatments results for the two pepper varieties. From the results analyzed, charcoal + NPK performed best for the two pepper varieties compared to other treatments. The control had a reverse result for the local pepper as it showed the biggest stem diameter mean of 1.67 cm. The NPK performed better than the charcoal plots. The Local pepper responded better than the Jalapeno pepper for all four treatments. With reference to Wanjari, Sigh and Ghosh (2004) work, NPK + Farm Yard Manures (FYM) significantly increase crop productions as seen in Figure 6 on the Charcoal + NPK for both pepper varieties. The tallest plant height means were recorded for charcoal + NPK applied plots.



	Charcoal	NPK	Charcoal + NPK		Charcoal	NPK	Charcoal + NPK
Date - 1	5	5.83	6.5		2.92	3.5	3.99
Date -2	10.5	12.25	14.58		9.75	10.33	10.33

Figure 7: three treatments effects on leaf width for the two pepper varieties for three dates

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Figure 7 showed the outcomes of treating peppers with three treatments of charcoal, NPK fertilizer and charcoal + NPK. The results indicated that charcoal applied plots performed lower with the following results for local pepper as 5 cm, 10.5 cm and 6.99 cm as leaf width means for date 1, 2 and 3 respectively. The NPK applied plot had the following means of 5.83 cm, 12.25 cm and 7.83 cm for date 1 to date 3 respectively for the same leaf width. The charcoal + NPK showed superior results for all three dates as 6.5 cm, 14.58 cm and 7.83 cm as means width respectively. Also for the Jalapeno, charcoal + NPK performed superior than the three treatments. The widest leaf mean was recorded for the local pepper during date 2 of data collection for charcoal + NPK fertilizer treatment. For economic consideration, charcoal application to crops influences growth as recorded by Al-Kaisi and Grote (2007).

4. Conclusions and Recommendations

Conclusions

Generally taller plants were observed in charcoal applied plots than no charcoal applied plots. Charcoal + NPK applied plots had the tallest plants than only NPK or charcoal alone. Local variety had taller plants than Jalapeno especially when charcoal and NPK were applied. Generally charcoal applied plots had taller plants, longer and wider leaves, and bigger stem diameter with more numbers of leaves on it. Similarly, charcoal applied plots had higher number of pods which were longer and heavier than no charcoal applied plots. In conclusion, Local

pepper performances were far superior to the Jalapeno pepper for all treatments. Subsequently, charcoal + NPK gave the best result in terms of growth of pepper crop.

Recommendations

From the finding of this research, I recommend the following:

1. Extension programs shall be designed to convey this information to farmers about the use of charcoal in crop production.
2. More research work can be conducted on process of improving soil fertility as to enhance crop productions.
3. This research work can be carryout on different crops to substantial the finding.
4. Determine the production level for all the treatments and how the growth parameters are correlated to the yields.

References

Al-Kaisi, M. M. and Grote, J. B. (2007). Cropping System Effects on Improving Soil Carbon Stocks of Exposed Subsoil. *Soil Science Society of America Journal*, 71(4): 1381-1389.

Azcon-Aguilar, C., Jaizme-Vega, M.C. and Calvet, C. (2002). The Contribution of Arbuscular Mycorrhizal Fungi for Bioremediation. Mycorrhizal Technology in Agriculture, Berlin.

Heerink, N. (2005). Soil fertility decline and economic policy reform in Sub-Sahara Africa. Land Use Policy, 22 (1), 67-74.

Kumar, A and Yavad, D. S. (2008). Long-term Effects of Fertilizers on the Soil Fertility and Productivity of a Rice-Wheat System. *Journal of Agronomy and Crop science*, 186(1): 47-54.

McCormack, S. A., Ostle, N., Bardgett, R. D., Hopkins, D. W., and Vanbergen A. J. (2013). Biochar in bioenergy cropping systems: Impacts on Soil Faunal communities and linked ecosystem processes. *Global Change Biology,* 5(2): 81-95.

Omotoso, S. and Shitu, O. (2007). Effect of NPK Fertilizer Rates and Method of Application on the Growth and Yield of Okra (abelmoschus esculentus (L) moench) at Ado-Ekitis Southwestern. *International Journal of Agricultural Research,* 2(7): 614-619.

Opala, P. A., Okalebo, J. R., Othieno, C. O. and Kisinjo, P. (2009). Effect of organic and inorganic phosphorus sources on maize yields in an acidic soil in western Kenya. Department of Soil Science, Moi University, Kenya.

Silva, M. W. K. P., Ranil, R.H.G. and Fonseka, R.M. (2012). An Emerging High Potential Underutilized Cucurbit. *Tropical Agricultural Research*, 23 (2),186–191.

Thanuji, T. V. (2002). Induction of rooting and root growth in black pepper cuttings (Piper nigrum L.) with the inoculation of arbuscular mycorrhizae. *Scientia Horticulturae,* 92(4), 339-346.

Vantsis, J. T. and Bond, G. (1950). Effect of charcoal on the Growth of Leguminous Plants in Sand Culture. *An International Journal of Annals of Applied Biology,*37(2): 159-168.

Wanjari, R. H., Singh, M. V. and Ghosh, P. K. (2008): Sustainable Yield Index: An approach to evaluate the sustainability of long-term intensive cropping in India. *Journal of Sustainable Agriculture 24(4): 39-54*.

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