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EFFECTS OF *MORINGA OLEIFERA* LAM, LEGUMINOUS PLANTS AND NPK FERTILIZER COMPARATIVELY ON ORANGE FLESHED SWEET POTATO IN ALLEY CROPPING SYSTEM

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Abstract

The research work conducted at the Teaching and Research Farm of University of Abuja was aimed at assessing the effect of *Moringa oleifera*, selected leguminous plants and inorganic fertilizer on the performance of orange fleshed sweet potato in Alley Cropping System. Randomized Complete Block Design (RCBD) using five treatments with three replications was applied. Data collected include: percentage survival of sweet potato, length per vine (cm), number of leaves per vine, leaf area of sweet potato, weed dry matter (g/m^2), yield of sweet potato roots. Highest number of leaves (28) per plant was recorded in the control plot while the plots with NPK fertilizer had the highest length per vine (94.55cm) though not significantly (p>0.05) different from others. Higher percent survival (88%) of sweet potato was recorded from control plots. Stands grownin *Arachis hypogeae* plots produced the highest leaf area (0.202m^2) while plots in which NPK fertilizer was applied experienced highest weed dry matter (4.083g/m^2) although highest root yield (1.2t/ha) was recorded from the plots with NPK fertilizer.

Keywords: Sweet potato, *Moringa oleifera*, Leguminous plants, alley cropping

Introduction

Over the past two decades, there has been much scientific interest in the potential of agroforestry of small – scale farmers one form of agroforestry that has received that particular attention is alley farming, intended as sustainable, intensive system that would radically improve the long term prospects of resource poor farmers (Jane, 1995).

Food security which is the availability of food to consumers is steadily decreasing because the availability of sufficient farmland is limited; therefore the crucial factors for the success of food security through improved farming system is efficient recycling of organic materials through agroforestry systems which aims at a compromise between continuous cropping and long fallow periods (Kang and Duguma, 1985; Snapp and Pound, 2008).

Alley cropping is an agroforestry system similar in approach to contour hedgerow system in which food crops are grown in alleys formed by hedgerows of trees and shrubs that are usually fast growing legumes, which enrich the soil through symbiotic nitrogen fixation and recycling nutrients from the soil (Blauser, 2002; Kang and Gutteridge, 1994). A number of fallow species had been considered suitable for alley cropping (Nair, 1993). The species considered suitable for alley farm in this study are either woody legumes or have high biomass index which include *Leucaena leucocephalla, Moringa oleifera* and *Arachis hypogea.*

Sweet potato is an important staple crop in Nigeria. It is a low input crop and serves as salvage crop among adults and children even in the face of malnutrition and used as sweetener and primary material for cakes and beverages (Amadi *et al.* 2011). The roots and leaves are sources of carbohydrates, protein and minerals, (Odebode, 2004). This study is aimed at achieving the performance of Orange Flesh Sweet Potato (OSFP) (*Ipomea batatas)* to Alley Cropping Systems. Other objectives include comparing the effects of Moringa species, Leucaena and Groundnut on the yield and yielding component of sweet potato and determine if the selected plants for the alley farming will be better alternative to the use of inorganic fertilizer in the growing of sweet potato.

Materials and method

Location of the experiment

The experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture, University of Abuja, Gwagwalada, Abuja, Nigeria.

Gwagwalada is located on latitude $6^0$45’ and $7^0$39’ East and longitude $8^0$25’ and $9^0$20’ North. The average temperature was 33^0C, 14% humidity during rainy (planting) season and an annual rainfall between 1,100 mm to 1,600 mm (Ishaya and Agbaje, 2009).

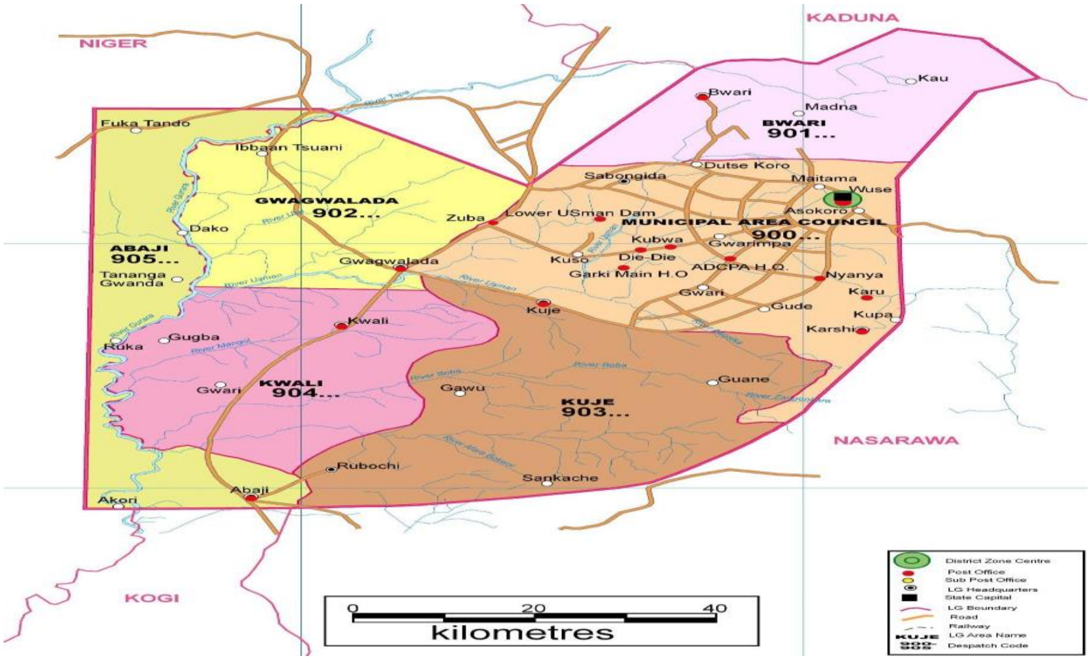

Fig. 1 Map showing Abuja, Federal Capital Territory, Nigeria

Soil Analysis and Experimental Material

Soil analysis report of the plot at the University of Abuja Crop Science Department Laboratory showed that the soil texture is sandy loam with sand, silt and clay having 10, 16 and 74% respectively with a pH of 5.80. The Total Nitrogen (N) and Available Phosphorus (P) in percentage are 0.175 and 12.25 respectively while potassium (K) exchangeable cations 0.23 cmol/kg.

The plant genetic material used was the Orange Flesh Sweet Potato (OFSP); *Ipomea batatas* vines introduced newly to farmers by National Root Crops Research Institute (NRCRI), Umudike, Nigeria as source of essential vitamins (Ekeledo and Ezigbo, 2011). Each vine used was 25cm long as recommended by the institute. Other plants were 4 weeks old *Moringa oleifera* seedlings, 6 weeks old *Leucaena leucocephalla, Arachis hypogeae (*Groundnut) seeds, and NPK 15:15:15.

Experimental Design

The treatment of which effects were evaluated includes: *Moringa oleifera*, *Leucaena leucocephalla*, *Arachis hypogea*, Inorganic fertilizer (NPK 15:15:15) at 200kg per hectare and Control. The *Moringa oleifera*, *Leucaena leucocephalla* and *Arachis hypogeae* were used as alley plants at 1m x 0.4m spacing. In the respective rows, the sweet potato vines were planted at 1m x 0.5m as fallow species.

A randomized Complete Block Design (RCBD) with 3 replications was used. Each replicate contains five plots. A plot measured 4m x 4m, separated by each other within the replicate by 0.5m alley and between replicate by 1m pathway. Thus, there were a total of 15 plots in the study. The experimental layout measured 22m x 14m. Each plot contains 4 rows of the individual plants. Ploughing and harrowing were done before planting.

Data Collection

Data collected include Leaf area of sweet potato (m^2), Length per vine (cm), Number of leaves per vine, Percentage survival of sweet potato, Weed density (g/m^2), Yield of sweet potato roots.

Data analysis

Data on all the parameters were subjected to Analysis of Variance procedure (ANOVA) using Randomized Complete Block Design. Treatment means were separated with Least Significant Difference (LSD). Treatment means were used to construct bar charts and table to show the trend of the results.

Results and Discussion

Percentage survival of sweet potato as influenced by *Moringa oleifera* and selected leguminous plants

The results of the analysis on the percent survival of sweet potatoes as influenced by *M. oleifera* and selected leguminous plants as shown in table I, indicates no significant ($p<0.05$) difference. The means showed that control plots had the highest survival of 87.75% but fairly same ($p<0.05$) with *Moringa* plot of 82.50%. Plots with *A. hypogea* and NPK fertilizer were significantly ($p<0.05$) the same with percentage survival of 79.75% and 79.17% respectively.
L. leucocephala recorded the lowest survival of 65.34% accordingly. Matimati *et al.* (2003) however reported that the survival of sweet potato is majorly attributed to the soil and weather conditions. Though, Insaidoo and Quarshie-Sam (2007) attributed *L. leucocephala* competition for shade at a later stage to low growth yield and survival rate in Garden egg intercrop.

Table 1: Percent survival of sweet potato as influenced by the treatments

TREATMENT	PERCENT SURVIVAL TIME (Weeks after planting)				MEAN
	2	4	6	8	
Moringa oleifera	90.67	85.67	85.00	68.67	82.50
Leucaena leucocephala	70.67	68.33	64.67	57.67	65.34
Arachis hypogea	91.67	81.67	76.67	69.00	79.75
NPK 15:15:15	87.67	81.67	75.00	72.33	79.17
Control	92	90	89	80	87.75
Significance (P<0.05)	NS	NS	NS	NS	

NS-Not significant

Length per vine of sweet potato as influenced by *Moringa oleifera* and selected leguminous plants

Though statistical analysis did not indicate significant ($p>0.05$) difference, the means showed that plots with the NPK 15:15:15 have vine length of 94.55cm per plant on the average. Sweet potato produced the shortest vines in stands grown in *Moringa* plots.

Under one year rotation, the fallow species would not have the required capacity to improve the soil fertility for their components effectively. Although it has been reported by Parrotta (2000) that leucaena can fix useful quantities of nitrogen even at early stage of growth. Palada *et al.*, (1992) also confirmed that *L. leucocephala* had nitrogen to the soil through mulcing at an early stage. However, the short vines of sweet potato in *M. oleifera* was as a result of competition for soil nutrients between the two speices as reported in Edward E *et al* (2012) in maize intercropping.

Table 2: Length per vine of sweet potato as influenced by the treatments

TREATMENT	LENGTH OF VINE TIME (weeks after planting)				MEAN
	2	4	6	8	
Moringa oleifera	10.30	28.03	50.07	93.77	45.54
Leuceana leucocephala	16.80	46.70	73.27	124.00	65.19
Arachis hypogea	16.03	41.43	66.70	99.43	55.92
NPK 15:15:15	23.37	81.47	113.93	159.43	94.55
Control	21.47	61.43	103.63	149.77	84.08
Significance ($P<0.05$)	NS	NS	NS	NS	

Number of leaves per vine

The number of leaves per vine of *Ipomea batatas* was significantly ($p<0.05$) affected by *Moringa oleifera* and selected leguminous plants. Stands of sweet potato grown in the control plots produced more leaves ($p<0.05$) than those grown in alleys of leguminous plants and moringa, though not significantly different ($p<0.05$) from those that were given chemical fertilizers NPK (fig 3). The lowest number of leaves per plant was recorded from stands intercropped with *Arachis hypogeae (*fig 3). Goldberge *et al. (2001)* reported that competition may be relatively rare early after germination, but may be critical in determining the final plant biomass. However, Rashmi and Debleena (2004) stated that plants can be grown in competition without major effects in their growth if they have different individual adaptations. Probably, the performance of sweet potato in the alleys of *Moringa, Leucaena* and *Arachis* was due to inter-specific competition between the sweet potato stands and individual fallow species while those in control and NPK fertilizer plots were able to fully utilize the available resources on the soil. Insaidoo and Quarshie-Sam (2007) also suggested that hedgerows should be periodically pruned to reduce shading and competition with associated crops. The hedgerows are yet to develop canopy because they were under one year of planting. Thus they compete favorably with associated crops so as to enable them become fully established. Hence both intra and inter-specific competition took place in these affected areas.

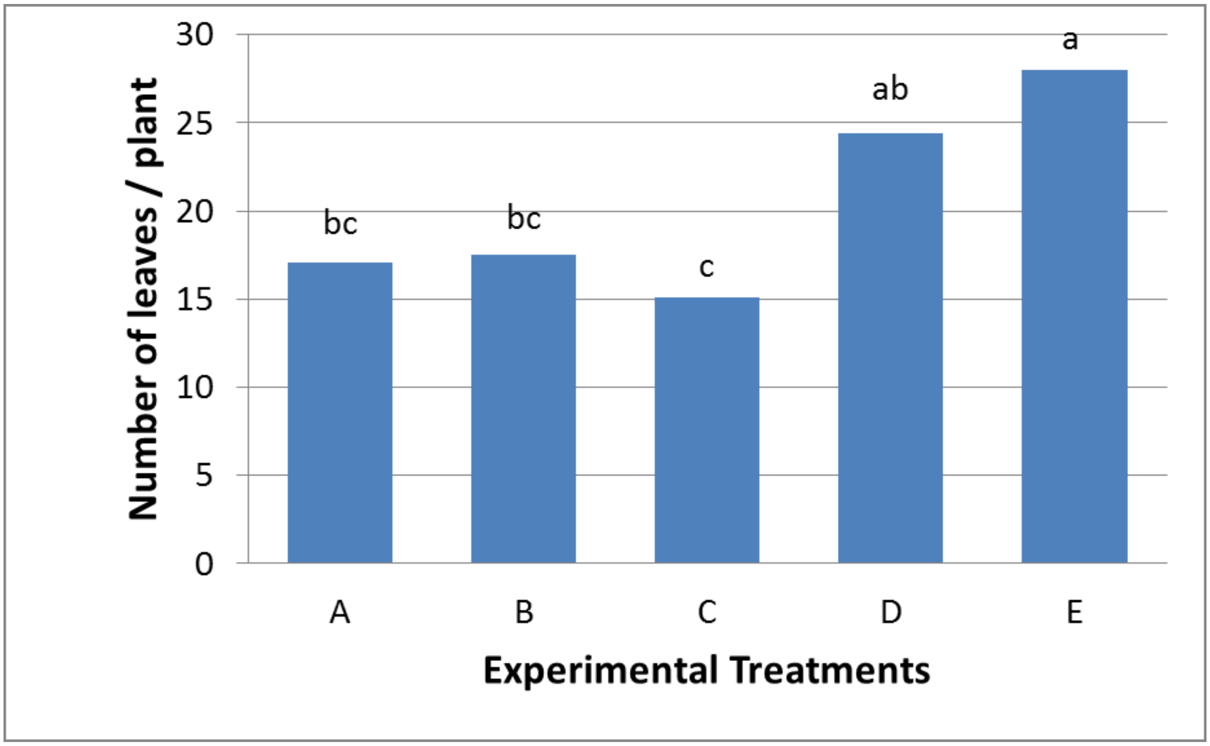

Fig 2: Effects of Moringa oleifera and selected leguminous plants on leaves production of Orange Flesh Sweet Potato

Bars with the same letters (a-c) are not significantly different, LSD= 8.92. Key: A = Moringa oleifera, B =Leucaena leucocephala, C = Arachis hypogeae, D = NPK 15:15:15 fertilizer, E = Control

Leaf area of sweet potato

Though statistical analysis did not indicate any significant ($p<0.05$) difference on the effect of different treatments on the leaf area of sweet potato, fig. 4 indicated that plots intercropped with *Arachis hypogeae* produced the highest mean leaf area of 0.202 m^2 at 12 Weeks After Planting. This was followed by the leaf area in *Leucaena plot*, control plot and NPK fertilizer plot respectively, which were fairly the same ($p<0.05$). Plots with *Moringa* produced the smallest leaf area of 0.063m2. Fadi Abass *et al*., (2014) confirmed that the leaf area is more affected under saline conditions than leaf number of sugar beets as a result of inhibition in expansion by the plant. However, findings by Oggema *et al.*(2007) suggested that leaf area of sweet potato is largely determined by varieties and soil components (especially saline and moisture).

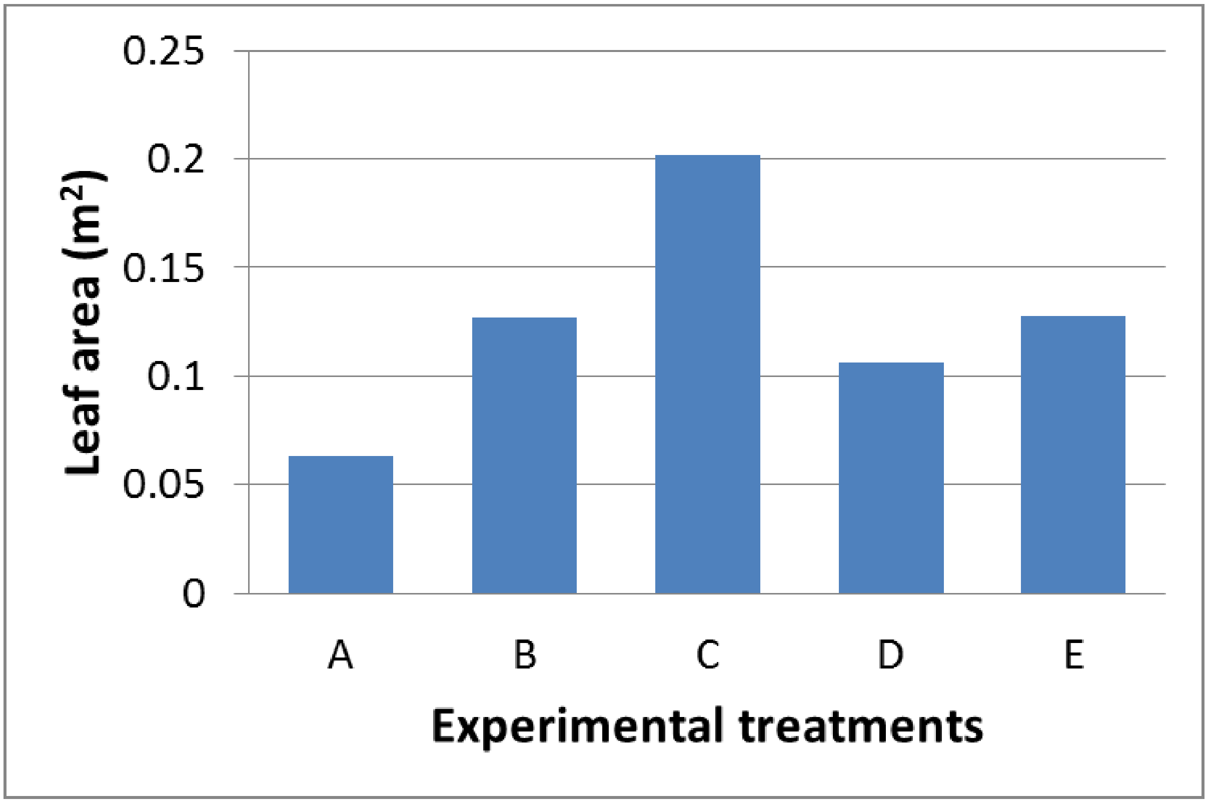

Fig 3: Effect of Moringa and selected leguminous plants on the leaf Area (m2) of sweet potato at 12WAP

Key: A = Moringa oleifera, B = Leucaena leucocephala, C = Arachis hypogeae, D = NPK 15:15:15 fertilizer,E = Control

Weed density (g/m^2)

Statistical analysis showed that weed density is higher in the plots that were treated with NPK fertilizer (fig 4), followed by those obtained from *Leucaena leucocephala* plots and control plots respectively. Thus, weed growth in NPK applied plot was rapid and dense because of quick availability of the basic nutrients released by the compound fertilizer NPK as it corresponds with the findings of Hussain *et al.*, (2007).

The lowest weed density was recorded from *Arachis hypogeae* plots. This result showed that as a cover crop, *Arachis hypogeae*has the capacity of continuous suppressing weed growth. This corresponded with Anyaegbu (1989) which reported that *Arachis hypogea* effectively suppressed weed growth in maize / groundnut intercropping trial.

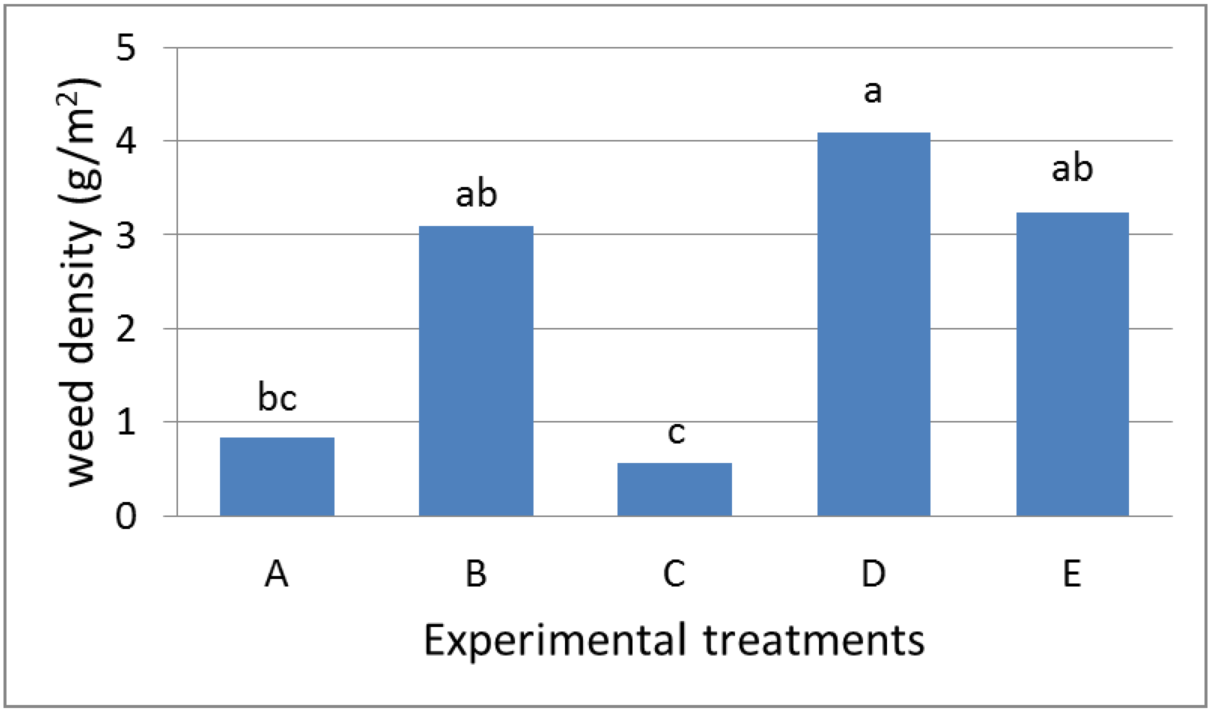

Fig 4: Effect of weed density (g/m2) as it was influenced by *Moringa oleifera* and selected leguminous plants on sweet potato production

Bars with the same letters (a-c) are not significantly different, LSD= 2.91.

Key: A = Moringa oleifera, B = Leucaena leucocephala, C = Arachis hypogeae, D = NPK 15:15:15 fertilizer, E = Control

Yield of sweet potato roots

The result of the analysis on the root yield of sweet potato as influenced by *Moringa* and selected leguminous plants is shown in fig. 5 below. The root yield remained fairly same ($p>0.05$) in the *Moringa* plots and those of *Leucaena, Arachis*and control plots. Highest root yield was recorded from plots that received NPK fertilizer. Palada *et al* (1992) concurred with the findings that there is a significant increase in the yield of vegetables at the first season in the alley cropping system. Also, Insaidoo and Quarshie-Sam (2007) reported increase in mean yield of *Solanum melongena* treated with fertilizer than the mulched *Leucaena* in their study. Isaac Nunoo *et al.,* (2014) further confirmed that fertilizer helps in improving soil fertility in addition to increase in yield in cocoa production with cereals.

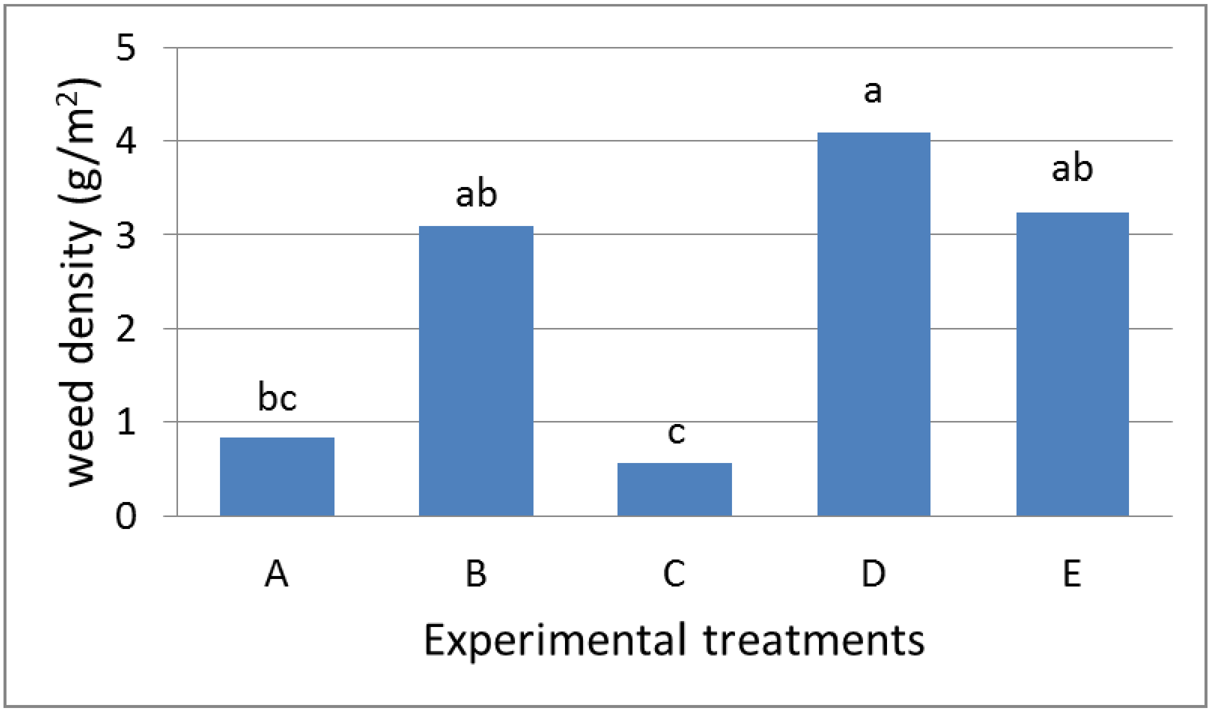

Fig 5: Yield (t/ha) of sweet potato as influenced by treatments

Bars with the same letters (a-c) are not significantly different.

Key: A = Moringa oleifera, B = Leucaena leucocephala, C = Arachis hypogeae, D = NPK 15:15:15 fertilizer, E= Control

Conclusion

The results of the trial showed that the control plot registered the highest number of leaves (Fig 3) as the leaf number was significantly ($p<0.05$) different as affected by Moringa and other selected leguminous plants. The chemical fertilizer plot had the highest length per vine of 94.55cm on the average (Table 2) while indicating non-significant ($p<0.05$) difference as it was affected by Moringa and selected leguminous plants. On percent survival of sweet potato, the control plots showed a dominating percent of survival of 87.75% (Table 1) though LSD ($p<0.05$) showed no significant difference in the treatments as they affects the alley species. Results on leaf area displayed plots with *Arachis hypogea* having the largest leaf area of 0.202m^2 at 12WAP (Fig 4). However, there was no significant ($p<0.05$) difference as indicated by the LSD. Statistical analysis also showed that weed density was higher in plots that were treated with NPK fertilizer though treatments were significantly ($p<0.05$) same (Fig. 5).

It has been reported that alley plants must be fully established before nodulation to replenish the soil with the required nutrients. This field trial was less than a year which is far less than the time required for full utilization of *Leucaena leucocephalla* and *Moringa oleifera* for alley purpose. However, the research which is a continuous one to ascertain the effects of Moringa and selected leguminous plants on the performance of Orange Flesh Sweet Potato had a positive response on sweet potato yield and the environment during the season.

References

Anyaegbu, P.O., 1989. Effects of lime and N-P-K (15:15:15) fertilizer on intercropped Maize and Groundnut. Master of Philosophy Research Project, University of Science and Technology. Port Harcourt, River State, Nigeria pp. 19.

Blauser, M.A., 2002. Alley Cropping: An Agroforestry Practice. University of Minnesota ExtensionService.www.extension.umn.edu/distribution/naturalresources/component/DD7 407b.html/downloaded.

Edward, E., Shabani, A.O. Chamshama, Yonika M.N. and Mathew, A.M., 2012. Effect of spacing and cutting management on survival, growth and biomass production of *Moringa oleifera* intercropped with maize on-farm at Gairoinland plateau, Morogoro in Tanzania. *Greener Journal of Agricultural Sciences.* 2(8), pp. 398-405, December 2012.

Ekeledo, E.N. and Ezigbo, V.U., 2011. Potential Use of Roots of Orange - Fleshed Sweet Potato Genotypes in the Production of B-carotene Rich Chips in Nigeria for National Root Crops Research Institute, Umudike. *African Journal of Food Science*.Vol. 6(2).Pp 29 - 33

Abbas, F., Al-Jbawi, E. and Ibrahim, M., 2014. Growth and chlorophyll fluorescence under salinity stress in sugar beet (*Beta vulgaris l.*) *International Journal of Environment*. Volume-3, Issue-1, Dec-Feb 2013/14 ISSN 2091-2854. Pp1-9

Goldberge, D.E., Turkington, R., Olsvig-Whittake, L., Dyer, A.R., 2001. Density dependence in an annual plant community: Variation among life history stages. *EcolMonog*r 71: 423-446.

HDRA, 2002.*Moringaoleifera.*A Multi - Purpose Tree: Ryton Organic Gardens Coventry CV8 3LG. UK.

Hiroshi, I., Hirorko, S., Niroko, S., Satoshi, I., Tadahiro, T. and Akio, M., 2000. Nutritive evaluation of chemical composition of leaves, stalks and stem of sweetpotato (*Ipomea batatas Poir*). *Food chemistry* 68: 350 – 367

Hussain, S., Siddiqui, S.U., Khalid, S., Jamal, A., Qayyum, A. and Ahmad, Z., 2007. Allelopathic potential of Senna (*Cassia angustifolia*Vahl.) on germination and seedling characters of some major cereal crops and their associated grassy weeds. *Pakistan Journal of Botany* 39(4), 1145-1153.

Insaidoo, T.F.G. and Quarshie-Sam, S.J., 2007. Evaluation of the effect of hedgerow intercroppingusing leucaenaleucocephalaand fertilizer application ongrowth and yield of garden eggs (Solanimmelongena).*Journal of Science and Technology,* Volume 27 (2) 2007.Pp64-69.

Nunoo, I., Nsiah Frimpong, B. and Kwabena Frimpong, F., 2014. Fertilizer use among cocoa farmers in Ghana: The Case of Sefwi Wiawso district. .) *International Journal of Environment*. Volume-3, Issue-1, Dec-Feb 2013/14 ISSN 2091-2854. Pp22-30.

Ishaya, S. and Abaje, B., 2009. *Assessment of Bore Wells Water Quality in Gwagwalada Town of FCT.*Journal of Sociology and Natural Environment.Vol. 1(2). Pp. 032 – 033.

Jane, C., 1995. Alley Farming: Have Resource - Poor Farmers Benefited? Overseas Development Institute ISSN: 13569228.

Kang, B.T. and Gutteridge, R.C., 1994. Forage Tree Legumes in Alley Cropping Systems.CAB International, Wallinford, Oxon, UK. ISBN 0958567719.

Kang, B.T. and Duguma, B., 1985. Nitrogen Management in Alley Cropping Systems. In: Proceedings of the International Symposium on Nitrogen Management in the Tropics.1B.,Haren (Gr), the Netherlands (In press).

Kang, B.T. and Wilson, G.F., 1987. The Development of Alley Cropping as a PromisingAgroforestry Technology. In: Steppler. H.A. and Nair P.K.R. (eds), Agroforestry a Deacade of Development. ICRAF, Nairobi, Kenya. Pp. 227 – 243.

Kang, B.T., Wilson, G.F. and Sipkens, L., 1981 Alley cropping maize (*Zea mays*) and leucaena (*Leucaena leucocephala*) in Southern Nigeria. *Plant and soil* 63, 165-179.

Matimati, I., Hungwe, E. and Murungu, F.S., 2005. Vegetative Growth and Tuber Yields of Micropropagated and Farm - retained Sweet Potato (*Ipomeabatatas*) Cultivars. *Journal of Agronomy*, 4:156 - 160.

Nair, PKR., 1993. *An Introduction to Agroforestry*.Dordrecht. Kluwer Academic Publishers. The Netherlands.First edition. Pp139.

National Population Commission, 2007. National Population Census for Nigeria 2006. Reported by the News Nigerian on http://www.thenewsng.com/ article on 10 January, 2007.

Odebode, S.O., 2004. Acceptability of Sweet Potato "Spari" and its Potentials for Enhancing Food Security and Economic Empowerment of Rural Women in South Western Nigeria.*The Nigerian Journal of Rural Sociology*.Vol. 4.Nos.1 & 2, 25 - 33, Nigeria.

Odendo, M. and Ndolo, P.J., 2002. Impact of Improved Sweet potato Varieties in Western Kenya: Farmers Perspective. KARI - Regional Centre, Kakamaga, Kenya. Draft Report. 23pp.

Palada, M.C., Kang, B.T., Claussen, S.L., 1992. Effect of alley cropping with Leucaena leucocephala and fertilizer application on yield of vegetable crops. *Agroforestry Systems* 19:139-147.

Parrotta, J.A., 2000. Leucaena leucocephala (Lam.) de Wit Leucaena, tantan. In: J.K. Francis and C.A. Lowe, eds. Bioecología de árboles nativos y exóticos de Puerto Rico y las Indias Occidentales. General Technical Report IITF- 15. U.S. Department of Agriculture, Forest Service, International Institute of Tropical Forestry, Río Piedras, PR. p. 308-316.

Jasrasaria, R. and Mitra, D., 2004. The effects of intraspecific and interspecific Competitiononplantgrowth.:ab.mec.edu/abrhs/science/hohn/apes/termprojects/exemplar.p df. Pp1-9.

Snapp, S.S. and Pound, B., 2008. Agricultural Systems: Agroecology and Rural Innovation for Development. Academic Press. 380pp.

Oggema, J.N., Kinyua, M.G., Ouma, J.P. and Owouche. J.O., 2007. Agronomic Performance of Locally Adapted Sweet Potato (Ipomeabatatas (L) Lam.) Cultivars Derived from Tissue Culture Regenerated Plants. *African Journal of Biotechnology* Vol. 6(12), pp.1418 – 1425.

Young, A., 1989. *Agroforestry for Soil Conservation*, CAB International, Wallingford, UK.Pp.9-11.