Original Research Article

EFFECTS OF ORGANIC AND INORGANIC FERTILZER ON THE EARLY GROWTH RESPONSE OF *Afzelia africana*

ABSTRACT

An experiment was conducted in the nursery of Department of Forestry Technology at the Federal College of Forestry Ibadan, Oyo state, Nigeria to determine the effect of organic and inorganic fertilizers on early growth response of *Afzelia africana*. Seedlings were collected from Forestry Research Institute of Nigeria, Ibadan, Oyo State and were transplanted into 2kg perforated polythene pots. The experiment was laid out in a completely randomized design with five treatments replicated three times. The treatments were: 20 t ha^{-1} water hyacinth compost (T1), 20 t ha^{-1} water hyacinth + poultry manure compost (T2), 20 t ha^{-1} poultry manure (T3) and 50 kg ha^{-1} NPK 20:10:10 (T4) and T5 - control (no fertilizer application). The compost was applied two (2) weeks before planting, while NPK 20:10:10 was applied two 2 weeks after planting. The experiment was monitored for eight (8) weeks after transplanting (WAT), while growth parameters were measured. The results of the study showed that application of fertilizers gave significant (p=0.05) increase in plant height (cm), stem diameter (mm), leaf production, and leaf area (cm^2) of *A. africana*. Plant height ranged from 41.43 cm in the control to 47.96 cm in the pots where 20t ha^{-1} water hyacinth compost was applied. Stem diameter also increased across treatments, while leaf production ranged from 9 in the control treatment to 14 in the pots with 20t ha^{-1} poultry manure. These results suggested that the incorporation of organic and inorganic fertilizers increased productivity of *A. africana.* However, application of 20 t ha^{-1} water hyacinth compost is recommended because it is available, affordable and environmentally friendly for the production of *A. africana* especially in the study area.

Keywords: Water hyacinth compost; *Afzelia africana;* NPK 20:10:10

INTRODUCTION

Forests and trees perform various functions in the ecosystem namely; aesthetics, provision of food and medicine, provision of shelter to wildlife and hygienic purpose (Agbogidi and Eshegbeyi, 2008). It is universally accepted that forests and trees carry out a fundamental role in soil and water resources conservation (Broadhead and Leslie, 2007; Hamilton, 2008). As population density increases and land for food production expands due to agricultural activities and urbanization, natural forests became degraded (Salim and Ullsten, 1999). The degradation has led to the disappearance of most species including agro forest trees and causing difficulty in growing some seedlings including *Afzelia africana* (Nwoboshi, 1985; Keay, 1989; Etukudo, 2000; Ezenwaka *et al*., 2004). *A. africana* is a leguminous tree found in the humid and dry forest savannah borders or semi-deciduous forest (Keay, 1989). It is used for soil conservation and improvement (Agbogidi and Onomeregbor, 2007). *A. africana* is a timber species with high forage, economic and pharmacological values. Its leaves are harvested for grazing during the dry season. The high demand for *A. africana* leaves, seeds, roots and barks for various uses has resulted in corresponding increase in the exploitation at such a rate that sustainability of this natural resource cannot be guaranteed (Mtambalika *et al*.,2014; Palgreave, 2002). Documented reports on the cultivation and seedling growth of this multipurpose tree known commonly as African mahogany are scarce (Okeke, 1996; Burkill, 1999; Etukudo, 2000; Agbogidi *et al.*, 2008). If the benefits derivable from *A. africana* must continue especially for the future generations, there is the need to stimulate farmers' interest in the cultivation of *A. africana* thereby helping to reduce poverty, helping in conservation role as well as to boost the source of revenue for the government. In the same vein, information on the domestication of the plant seeds and seedlings are scanty, mainly due to degradation caused by human influences. Consequently, the need to acquaint farmers with the most successful soil or manures that could enhance the growth of *A. africana* seedlings cannot be overemphasized. This study was aimed at investigating the effect of organic and inorganic fertilizers on the seedling establishment of *A. africana* with a view to recommend the best fertilizer to *A. africana* growers especially at the nursery stage and to multiply this multi-purpose species.

MATERIALS AND METHODS

The experiment was carried out in 2018 at nursery site of the Department of Forestry Technology, Federal College of Forestry Jericho Ibadan (Latitude 07^0 27^1N and longitude 03^0 53^1E), Ibadan, Nigeria (FRIN Meteorological Station, 2018). The annual rainfall is 1250 mm with a bimodal pattern and has a minimum temperature of 21.9 ^{0}C and maximum temperature of 35.5 ^{0}C. The experiment was laid out in a Complete Randomized Design with five treatments replicated three times. The treatments were: 20 t/ha water hyacinth compost (T1); 20 t ha^{-1} water hyacinth + poultry manure compost (T2); 20 t/ha poultry manure (T3); 50 kg/ha N:P:K 20:10:10 (T4); and control (no fertilizer application) (T5). The compost was applied two (2) weeks before planting. Eight week old seedlings of *A. Africana* were collected from Forestry Research Institute of Nigeria (FRIN), Ibadan, Oyo State, and potted into 2kg polythene pots filled with different media treatments, watered and allowed to stabilize for two weeks before the commencement of growth assessment. Plant height was measured with a meter rule at the distance from soil level to terminal bud. Leaf production was determined by counting. Stem diameter was measured with venier caliper. Data collected were analysed statistically using Genstat Software Package and were subjected to analysis of variance. Means were separated using Duncan's multiple range test (DMRT) at 5% level of significance.

RESULTS

Table 1: Pre-planting soil physical and chemical properties of the experimental site

Soil parameters	Content in soil
pH (H_2O)	5.8
Organic carbon (g kg^{-1})	9.0
Total nitrogen (g kg^{-1})	1.0
Available phosphorus(mg kg^{-1})	6.0
Exchangeable cations ($cmol_c$ kg^{-1})	
Ca	1.32
Mg	0.25
K	0.11
Na	0.31
Extractable micronutrient (mg kg^{-1})	
Mn	302.0
Fe	265.0
Cu	3.39
Zn	1.2
Exchangeable Acidity ($cmol_c$ kg^{-1})	0.40
Particle size distribution (g kg^{-1})	
Sand	838
Silt	54
Clay	108
Textural class	Sandy loam
Bulk density (g cm^{-1})	1.62
Saturated hydraulic conductivity (cm hr^{-1})	12.4

Table 2: Chemical properties of the combinations of compost used

Parameter	Poultry manure	Water hyacinth compost	Water hyacinth + Poultry manure compost
pH (H_2O)	6.8	5.89	5.76
Organic carbon (%)	22.94	31.92	32.11
Total Nitrogen (%)	3.30	2.6	1.73
C:N	6.8	12.52	43.99
P (%)	0.83	1.24	1.55
K (%)	1.80	0.47	0.80
Ca (%)	2.56	1.6	1.80
Mg (%)	1.58	4.30	0.92

The physical and chemical prorperties of the soil (0 – 15 cm depth) at the experimental site before planting are as presented in Table 1. The soil is sandy loam, slightly acidic, high bulk density (1.62 g cm^{-3}) and has been classified as an Alfisol (Smyth and Montgomery, 1962) with its distinctive characteristics. The data in Table 1 further confirms this assertion and also reveals that the soils are moderate in Zn, low in K (0.11 $cmol_c$ kg^{-1}), organic carbon (9.0 g kg^{-1}), total nitrogen (1.0 g kg^{-1}) and P (6.0 mg kg^{-1}). Saturated hydraulic conductivity value of 12.4 cm hr^{-1} indicated a well-drained soil.

The chemical composition of water hyacinth compost, poultry manure and water hyacinth + poultry manure compost used is as presented in Table 2. The pHs of all the organic fertilizers were all acidic with the water hyacinth + poultry manure compost having the most acidic pH of 5.76. Organic carbon, C/N and P were highest in the mixture of water hyacinth + poultry manure compost. Poultry manure was highest in N, K and Ca content

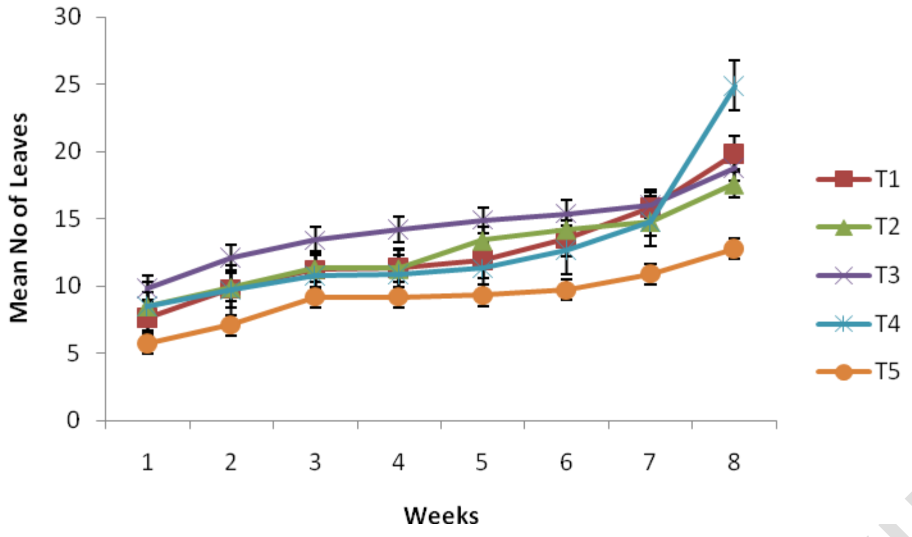

Figure 1: Growth pattern of number of leaves of *Afzelia africana* seedlings as influenced by fertilizers

T1 (20 t ha^{-1} water hyacinth); T2 (20t ha^{-1} water hyacinth + poultry manure compost); T3 (20t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

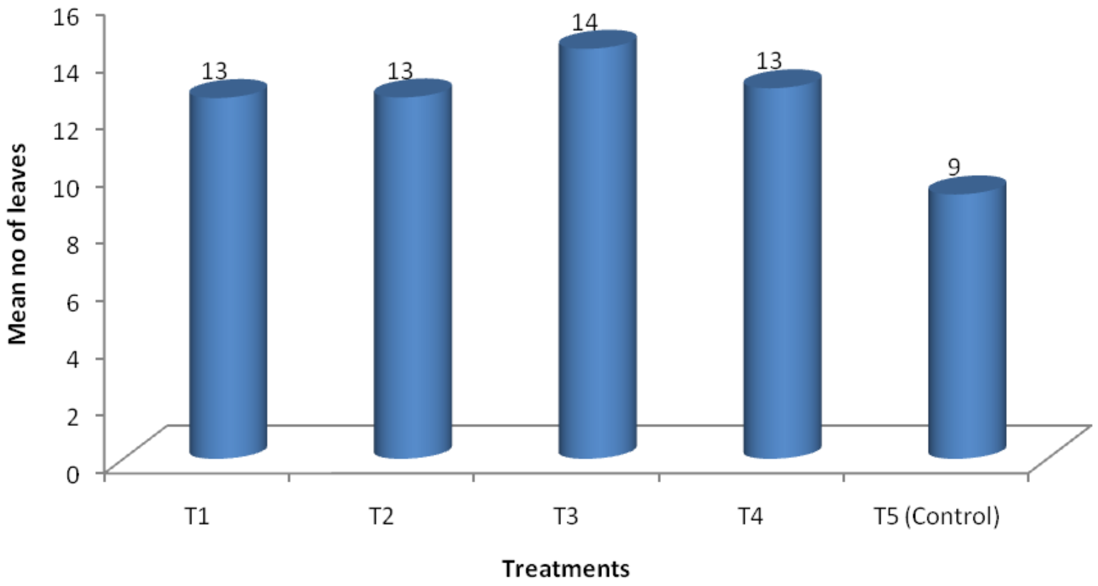

Figure 2: Effects of fertilizers on number of leaves of *Afzelia africana* seedlings

T1 (20 t ha^{-1} water hyacinth); T2 (20 t ha^{-1} water hyacinth + poultry manure compost); T3 (20 t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

Effect of organic and inorganic fertilizers on number of leaves of *Afzelia africana* seedling

Figure 1 showed the growth pattern of leaf production of *A. africana* seedlings as influenced by the application of organic and inorganic fertilizers. Results revealed that mean leaf production of *A. africana* increased across the study period for T3 (20 t ha^{-1} poultry manure) which recorded the highest mean number of leaves across the weeks and except in the last week while T5 (top soil only) had the least mean number of leaves all through the duration of the experiment.

The mean effects of organic and inorganic fertilizers on the number of leaves of *A. Africana* as presented in Figure 2. Leaf production varied across treatments and differs significantly (p=0.05) throughout the experiment. Leaf production ranged from 9 in the control to 14 in the pots where 50 kg ha^{-1} NPK 20:10:10 was applied. The highest mean leaf production of *A. africana* was observed in T3 with 14 and it was closely followed by T1, T2, and T4 with 13 and the least was found in T5 (control) with 9.

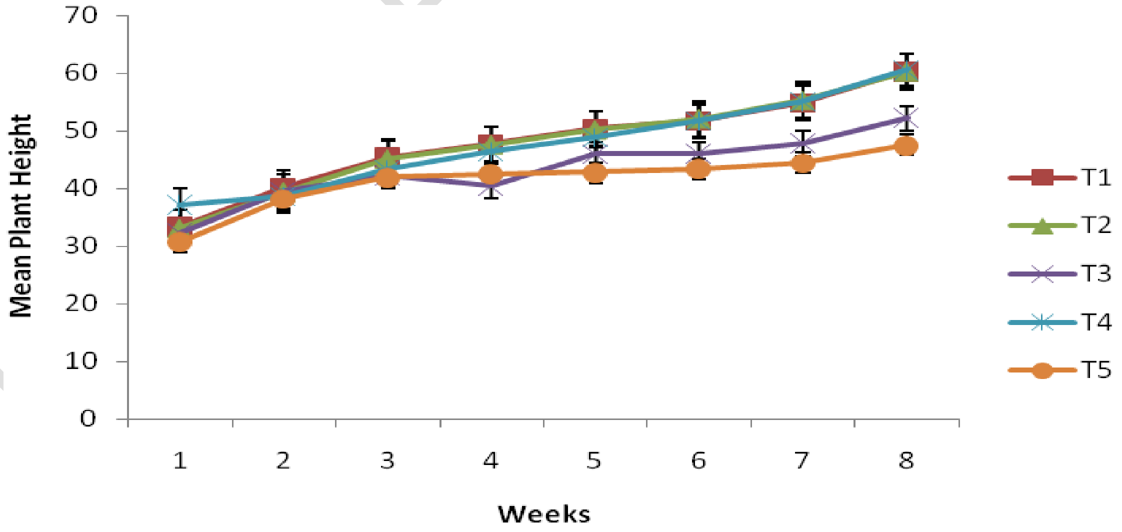

Figure 3: Growth pattern of height of *Afzelia africana* seedlings as influenced by fertilizers

Legend: T1 (20t ha^{-1} water hyacinth); T2 (20t ha^{-1} water hyacinth + poultry manure compost); T3 (20t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

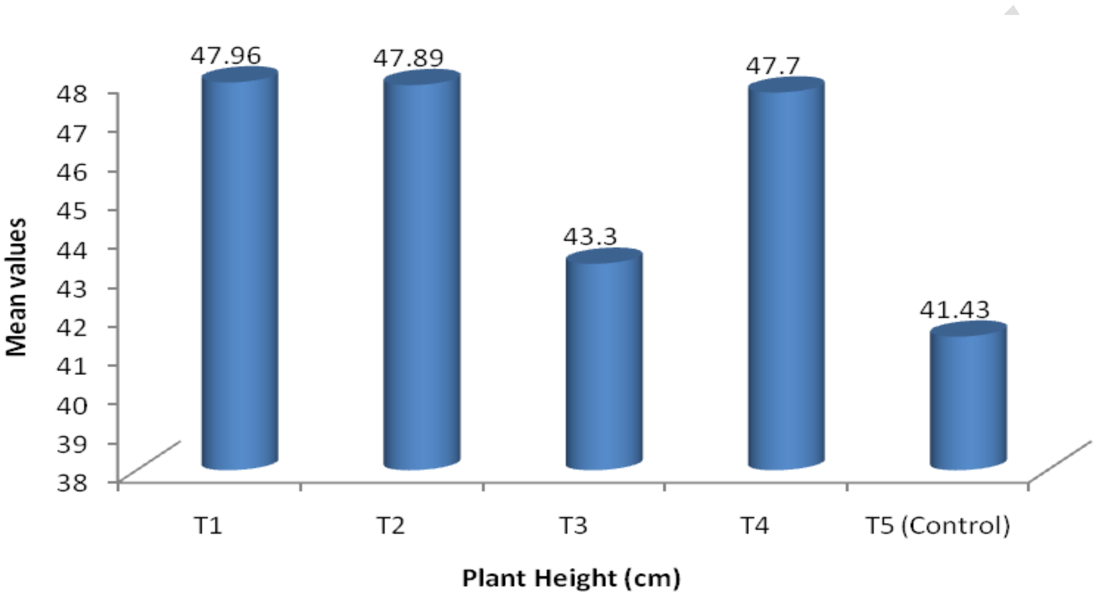

Figure 4: Effects of fertilizers on plant height of *Afzelia africana* seedlings

T1 (20 t ha^{-1} water hyacinth); T2 (20 t ha^{-1} water hyacinth + poultry manure compost); T3 (20 t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

Effect of organic and inorganic fertilizers on plant height of *Afzelia africana* seedling

Results in Figure 3 showed the growth pattern of plant height of *A. africana* seedlings. The control treatment followed similar trend with the growth pattern of number of leaves and performed poorly in comparison to others in terms of the number of leaves produced. The highest mean height of *A. africana* was observed in T1 (20t/ha water hyacinth compost) with T2 (20 t ha^{-1} water hyacinth + poultry manure compost) closely followed and T5 (control) performed least. The effect of organic and inorganic fertilizers on the plant height of *A. africana* is as presented in Figure 4. Plant height increased across treatments but did not differ significantly (p=0.05) throughout the experiment. 20t ha^{-1}water hyacinth compost (47.96 cm) had highest plant height followed by 20 t ha^{-1} water hyacinth + poultry manure compost (47.89 cm) and least by control pot (41.43 cm).

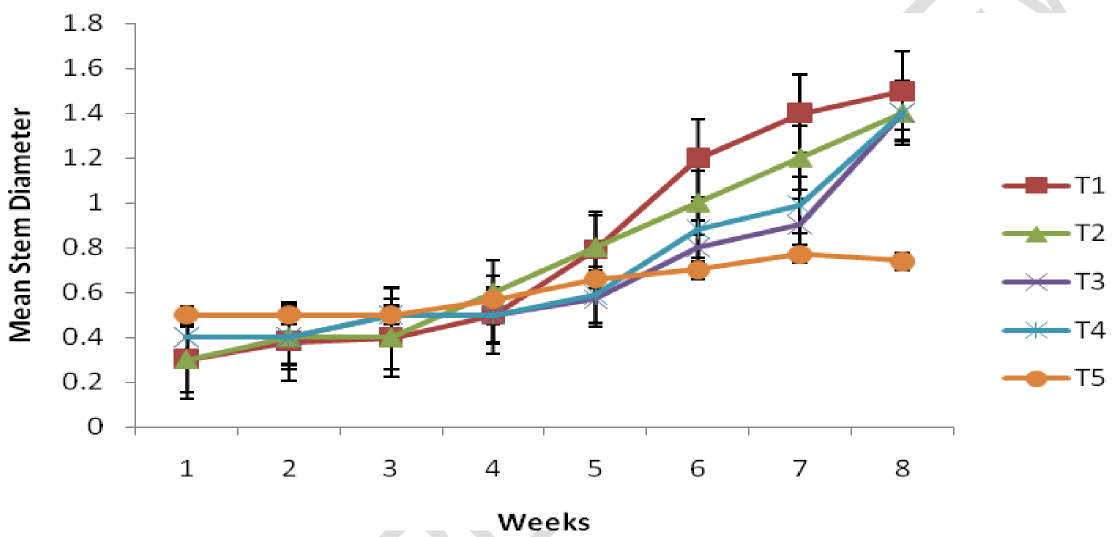

Figure 5: Growth pattern of stem diameter of *Afzelia africana* seedlings as influenced by fertilizers

T1 (20t ha^{-1} water hyacinth); T2 (20t ha^{-1} water hyacinth + poultry manure compost); T3 (20t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

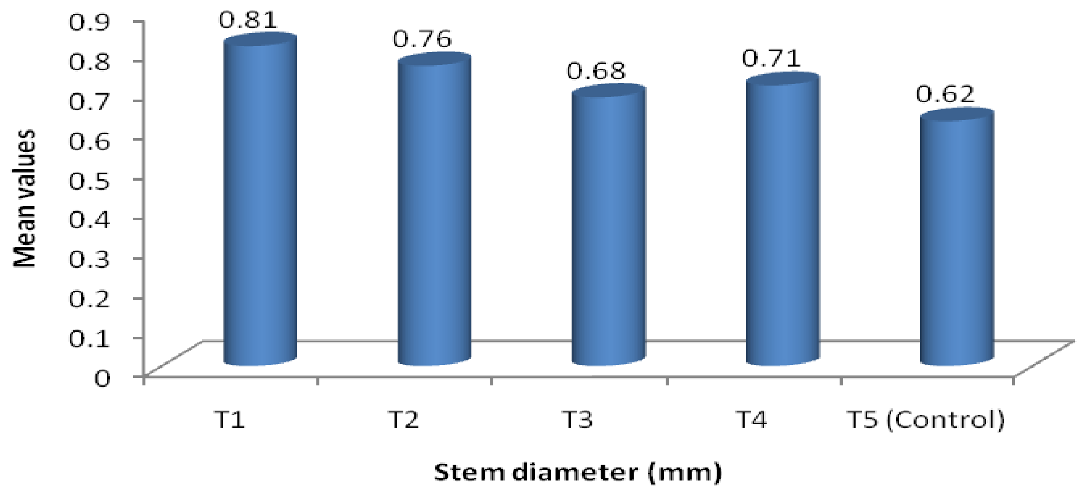

Figure 6: Effects of fertilizers on stem diameter of *Afzelia africana* seedlings

T1 (20 t ha^{-1} water hyacinth); T2 (20t ha^{-1} water hyacinth + poultry manure compost); T3 (20 t ha^{-1} poultry manure); T4 (50 kg ha^{-1} NPK 20:10:10); T5 (control-no fertilizer application).

Effect of organic and inorganic fertilizers on stem diameter of *Afzelia africana* seedling

Results in figure 5 showed the growth pattern of stem diameter of *A. africana* seedlings, the control experiment performed well at the beginning but poorly at the end of the eighth week, with T1 (20 t ha^{-1} water hyacinth) performing best.

The effect of organic and inorganic fertilizers on the stem diameter of *A. africana* is presented in Figure 6. Stem diameter increased across treatments but did not differ significantly (p=0.05) throughout the experiment. 20t ha^{-1} water hyacinth compost (0.81 mm) had highest stem diameter followed by 20 t ha^{-1} water hyacinth + poultry manure compost (0.76 mm) and least by control plot (0.62 mm).

DISCUSSION

The major factor affecting plant growth in the tropics is the nutrient deficiency in tropical soils resulting from degraded farmland. The low levels of N, P, and OC observed in the experimental soil indicated that the soil had a low fertility status. The value obtained for N, P, K and OC is below the critical range (Adeoye and Agboola, 1985, Akinrinde, *et al*., 2005), thus indicating poor soil fertility not suitable without the addition of external input for planting *A. africana*. The chemical composition of water hyacinth compost, poultry manure and water hyacinth + poultry manure compost used in the experiment was relatively high in major elements (N, P, K, Ca and Mg). The OC content of all the organic fertilizers were less than the values obtained for the composts of *Azadirachta indica*, *Albizia lebbeck* and *Khaya senegalensis* by Daldoum and Hammad (2015).

The application of the various fertilizers increased the growth of *A. Africana* this agreed with the findings of Uddin (2014) where organic fertilizers enhanced the seedling growth of some leguminous forestry species. This could result from the nutritional benefits of organic and inorganic fertilizers which include improvement of soil fertility. The result obtained from the plant height showed that water hyacinth compost significantly induced the shoot growth, leaf production and stem diameter of *A.africana* seedlings. This is in support with Razaq, *et al*. (2017); Talkah (2015) and Cuesta (2010) that reported that plant height and number of leaves of plants treated with water hyacinth compost had been used and shows better performance than control. Lata (2013) that experimented with water hyacinth manure on *Coriandrum sativum* revealed positive response with increase in manure rates. Supported by study done by Osoro, *et al*., (2014) and Aboul-Enein *et al*., (2011) who advocated that water hyacinth has good N, P, K absorbing capacity from water and thus can be used as a good source of compost material to serve as fertilizer in soil with poor amount of N, P, K and C values. Water hyacinth which used to be tagged as waste and nuisance to aquatic environment can be converted to compost for fertilizing plants at the nursery stage in order to improve early growth. This might replace use of expensive, scarce and environmentally hazardous inorganic fertilizers in forest nursery work.

CONCLUSION

Organic and inorganic fertilizer had effect on the growth of *A. africana*. It could be observed from the result obtained that there were increases in plant height, stem diameter and number of leaves. However, there was poor performance throughout the assessment period in control treatment when compared to other treatments in terms of the number of leaves produced per plant. Seedlings in 50 kg ha^{-1} NPK 20:10:10 (T4) presented best at week eight though it was poor at the early stage of the experiment. Seedlings with 20 t ha^{-1} poultry manure (T3) performed well from the beginning of the experiment up to the penultimate week to the end of the experiment. Application of 20 t ha^{-1} water hyacinth compost gave the highest plant height. Stem diameter also increased appreciably across treatments. Therefore, it can be concluded and recommended that 20t ha^{-1} water hyacinth compost can be used by farmers to increase the growth of *A. africana*.

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