Original Research Article

Influence of Arbuscular Mycorrhiza Fungi (*glomus clarum*) and compost on early growth response of *Parkia biglobosa* under a greenhouse condition.

Abstract

Arbuscular mycorrhizal fungi (AMF) can be considered as a key organisms of the soil–plant system as it ultimately contributes to the uptake of nutrients and water. AMF plays a role in the structural stability of soil which governs most soil activities. Compost may provide a suitable habitat and energy source for mycorrhizal growth, which is also a benefits in view of soil productivity. The impact of a combination of compost and mycorrhizal on plant growth was assessed in this study. Hence, experiment was conducted to investigate the influence of compost and mycorrhizal on the growth response of *Parkia biglobosa* under a greenhouse condition. In the greenhouse of the Department of Bioscience, Forestry Research Institute of Nigeria. Ibadan, a 2 x 5 factorial experiment in a complete randomized design was conducted; two levels of mycorrhiza (with and without); five levels of composts (10t/ha, 20t/ha, 30t/ha, 40t/ha and no amendments) in two kilogram soils under four (4) replications was set up. Laboratory analyses of soil and organic amendments incorporated in the soils were done. Data on growth parameters were taken fortnightly. The data was statistically analyzed and the mean were separated using Duncan Multiple Range Test (DMRT). The results shows that there was significant difference ($p<0.05$) in the plant height of *parkia biglobosa* between mycorrhizal and non-mycorrhizal plants across weeks in after transplanting (WAT), compost application with the interaction of AMF at 40 t ha^{-1} recorded the highest plant height and number of leaves at 16WAT with 35.14cm and 29.75 respectively, which are relatively comparable to other treatments used, the least plant height and number of leaves were observed when -AMF 0(control) was used as an amendment with 23.00cm and AMF 0 t ha^{-1} (15.05) respectively. For collar diameter, all the treatments are comparable to one another except + AMF 30t/ha which produced the lowest collar diameter with mean value of 2.97mm. Based on the description of results above, it can be concluded that: The Inoculation of the AMF and compost significantly affect the early growth performance of *parkia biglobosa*, thus providing optimum soil physical conditions for it growth.

Keywords: ***Inoculation, Mycorrhizal, Growth parameters, Parkia biglobosa.***

Introduction

Arbuscular Mycorrhizal Fungi (AMF), significantly influence soil fertility and the habitat for microbial communities. Soil quality is also improved by increasing the total microbial biomass and species abundance. Soil microbes are known to produce polymers that also serve as aggregate binding agents (Jastrow *et al.,* 1998). Soil organic matter is known to influence AMF (Warnock et al., 2007). The influence of organic matter on AMF hard contradicting different results which indicating variable responses due to varying host plants and AMF species (Gaur and Adholeya, 2000). Secondary metabolites produced by microorganisms associated in decomposition of organic matter and soil microbial activity can be either stimulating or inhibitory to AMF was also increased after organic matter addition increasing the concentration of nutrients in the soil and thus affected AMF development and functions (Beyer et al., 1999; Gryndler et al., 2009.). The frequency occurrence of *G.species* declined with increasing organic matter content while *G.sinousum* and *G. Taiwanese* were found only when some less than 1.5% (Covacevich, 2007).

Organic matter improves the soil structure, reduces soil erosion, has a regulating effect on soil temperature and helps the soil to store more moisture, thus significantly improving soil fertility. The depletion of the organic matter content of fragile soils of the humid tropics caused by intensive tillage, hence additions of organic manures such as compost and has been recommended (Robert *et al.,* 1995). Compost is a very important input material for organic greenhouse production. Organic greenhouse production may vary in the level of intensity, but it is generally a system with high turnover rates of organic matter, high inputs of both nutrients and energy, and high production levels. Compost is used as an important source of organic matter and nutrients in greenhouse horticulture, and is an important component of growing media for nurseries. Compost plays an important role in building a resilient farming system, by providing both the energy sources and the nutrients to sustain soil biodiversity (Van der Wurff., 2016).

In West Africa Parkia species are commonly used for condiment production. According to Oladunmoye (2007) common species within the genus Parkia include Parkia biglobosa, Parkia filicoidea ,Parkia bicolor, and Parkia biglobosa although Sina and Traoré (2002) had indicated that they are synonyms. Parkia species. are widely distributed in across savanna belts across West Africa. Unfortunately, the trees which have long gestation period are threatened for different end uses including charcoal production. They added that it is a food species whose importance is recognized both regionally and internationally because in some societies on the African continent it is not an ordinary food item but a therapeutic food and a source of income.

Major soils found in Nigeria agro-ecological zones are coarse-textured surface soil with low organic matter and chemical fertility. Aggregates of these soils are weak; they lose productivity fast and do not retain adequate water and nutrients for sustainable production (Salako, 2003). These characteristics imply that even with the best of soil fertility amendments, soil physical conditions must be managed to achieve sustainable crop production. Therefore, this experiment was conducted to determines the growth response of *Parkia biglobosa* to AMF (*glomus* clarum) under the application of compost at different level

MATERIALS AND METHOD

An experiment to assess the influence of Arbuscula Mycorrhiza Fungi (*Glomus clarum*) and compost on the growth and soil properties of *Parkia biglobosa* in soil was set up at the screen house of the Department of Bioscience, Forestry Research Institute of Nigeria.

Collection of soil samples

Soil samples was collected from farm practical area (FAP), Federal College Forestry, Ibadan. Top soil of 0 – 20 cm depth was used for the experiment. The soil was air dried; grounded and sieved using 2mm sieve to remove gravel and large plant roots. Soil samples was chemically analyzed for nitrogen and other nutrient content. Two-kilogram (3kg) soil was weighed in a polyethylene bag and incorporated with organic manure at different levels and mycorrhizal (*Glomus clarum)*.

Organic Amendments

Compost was analyzed to determine the NPK content of each amendment. The phosphorus content was used to determine the quantity of fertilizer to apply to *parkia biglobosa*. Compost was incorporated into the soil, two weeks before planting for mineralization at different levels.

Mycorrhizal inoculation

The arbuscular mycorrhizal fungi (AMF) inoculum of *Glomus clarum* were obtained from Soil Microbial Laboratory, University of Ibadan. The spores of *Glomus clarum* were propagated in sterilized sand with corn as a host. Approximately 20g of *Glomus clarum* inoculant with 50 spores was placed into a hole in the center of the polybag by placing it below the root of the plants. For non-inoculated plants, 20g of sterilized soil were used to replace *Glomus clarum* in each polybag in order to provide the same soil condition.

Experimental design

The experimental design was a 2 x 5 factorial arranged in a Completely Randomized Design (CRD) with four replicates making a total of 40pots. The treatments used were as follows.

Organic amendments at 5 levels: 10t/ha, 20t/ha, 30t/ha, 40t/ha and no amendments (0).

Mycorrhizal (20g) flat rate applied to pots

Data collection

The following growth parameter of *parkia biglobosa* was taken:

i) Plant height
ii) Number of leaves
iii) Collar diameter
iv) Dry matter yield

Soil analysis

Soil Total Carbon; The total carbon content in the soil were determined by using total combustion method. Soil available phosphorus in soil were determined by using Bray and Kurtz method no 2 extractant (Bray and Kurtz, 1945). Total nitrogen of soil sample were determined by using dry combustion method. Exchangeable K, Ca and Mg for soils was determined by using modified Shaking Method (Schollenberger and Simon, 1945) where 1M of ammonium acetate (NH4OAc) was used as reacting reagent.

Statistical Analysis

Quantitative data will be analyzed using the ANOVA procedure and means separated using the Duncan Multiple Range Test (DMRT) at 5% probability (SAS Institute, 2002).

Results and Discussion

Table 1: Chemical properties of soil and compost used

Properties		Soil	Compost%
pH	(1:25)	6.5	5.9
T.N	g/kg	0.27	0.93
Avai.P	mg/kg	19.4	0.02
K	cmol/kg	0.06	0.0004
Fe	mg/kg	269	3.53
Mg	cmol/kg	0.76	0.33
O.C	g/kg	1.34	10.97
Na	cmol/kg	3.19	0.014

Key: OC = Organic carbon, N = Nitrogen, P = Phosphorous, K = Potassium and Mg = Magnesium, Fe = iron.

Table 2: Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and Compost on the plant height of *Parkia biglobosa*

Treatments	2	4	6	8	10	12	14	16
+Amf 0	20.18^{abc}	23.38^{abc}	24.12^{ab}	26.38^{abc}	26.00^{cd}	30.38^{a}	31.62^{a}	31.68^{abc}
-Amf 0	15.03^{bc}	15.25^{cd}	16.12^{bc}	18.17^{d}	19.00^{d}	19.00^{b}	20.17^{bc}	23.00^{abc}
+Amf 10	12.62^{c}	14.89^{d}	19.67^{c}	27.60^{bc}	29.17^{abc}	32.71^{b}	33.12^{c}	34.93^{c}
-Amf 10	18.80^{a}	20.12^{bcd}	26.82^{a}	29.67^{ab}	28.33^{abc}	29.00^{ab}	29.14^{abc}	29.57^{abc}
+Amf 20	22.10^{a}	25.15^{ab}	27.25^{a}	27.85^{abc}	28.75^{abc}	30.38^{a}	31.33^{ab}	31.48^{abc}
-Amf 20	20.73^{abc}	21.10^{bcd}	20.32^{ab}	22.88^{abc}	24.21^{abc}	21.38^{ab}	22.38^{abc}	26.00^{abc}
+Amf 30	18.00^{abc}	18.95^{bcd}	19.25^{bc}	22.18^{abc}	23.25^{abc}	24.38^{ab}	25.50^{abc}	26.50^{abc}
-Amf 30	21.00^{abc}	21.25^{bcd}	23.15^{abc}	24.58^{abc}	26.15^{abc}	27.67^{ab}	28.50^{abc}	28.50^{abc}
+Amf 40	25.25^{a}	27.88^{a}	28.13^{ab}	30.23^{a}	30.50^{a}	31.64^{ab}	32.53^{abc}	35.14^{ab}
-Amf 40	20.23^{abc}	20.88^{bcd}	21.88^{abc}	23.60^{bcd}	23.10^{cd}	23.00^{a}	23.19^{abc}	24.88^{bc}

+AMF (inoculated with *Glomus clarum), -AMF (*un-inoculated), *compost (0, 10* t ha-^{1}, *20* t ha-^{1},*30* t ha-^{1},*40* t ha-^{1}

Table 3: Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and compost on the collar diameter of *Parkia biglobosa* under a greenhouse condition

Treatments	2	4	6	8	10	12	14	16
+Amf 0	2.69 ^{ab}	2.38 ^{abc}	2.38 ^{abc}	2.43 ^{abc}	2.63 ^{b}	2.97 ^{abc}	3.09 ^{abc}	3.65 ^{abc}
-Amf 0	2.01 ^{ab}	2.62 ^{abc}	2.76 ^{abc}	2.67 ^{abc}	2.67 ^{ab}	2.89 ^{abc}	3.11 ^{abc}.	3.64 ^{abc}
+Amf 10	2.18 ^{ab}	2.53 ^{abc}	2.53 ^{abc}	2.87 ^{abc}	2.87 ^{ab}	3.05 ^{abc}	3.17 ^{abc}	3.93 ^{abc}
-Amf 10	1.78 ^{ab}	2.22 ^{abc}	2.69 ^{abc}	2.76 ^{abc}	3.45 ^{ab}	3.69 ^{abc}	3.69 ^{abc}	3.73 ^{abc}
+Amf 20	1.83 ^{a}	1.83 ^{bc}	1.99 ^{abc}	2.18 ^{ab}	2.18 ^{c}	2.56 ^{abc}	2.98 ^{abc}	3.11 ^{abc}
-Amf 20	1.38 ^{ab}	1.86 ^{bc}	2.07 ^{abc}	2.11 ^{abc}	2.65 ^{b}	3.00 ^{abc}	3.04 ^{abc}	3.22 ^{abc}
+Amf 30	2.08 ^{ab}	2.08 ^{bc}	2.42 ^{abc}	2.67 ^{abc}	2.93 ^{b}	2.99 ^{abc}	3.17 ^{abc}	3.83 ^{ab}
-Amf 30	1.25 ^{ab}	1.25 ^{bc}	1.45 ^{bc}	1.61 ^{ab}	1.99 ^{bc}	2.54 ^{abc}	2.63 ^{abc}	2.97 ^{abc}
+Amf 40	2.42 ^{b}	2.73 ^{abc}	3.12 ^{abc}	3.50 ^{abc}	3.59 ^{a}	3.91 ^{abc}	3.92 ^{abc}	4.05 ^{abc}
-Amf 40	2.17 ^{ab}	2.43 ^{abc}	2.79 ^{abc}	2.45 ^{abc}	2.95 ^{c}	3.11 ^{abc}	3.13 ^{abc}	3.49 ^{abc}

+*AMF* (inoculated with *Glomus clarum), -AMF (*un-inoculated)*, compost (0, 10* t ha-^{1},*20* t ha-^{1},*30* t ha-^{1},*40* t ha-^{1}

Table 4: Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and compost on the number of leaves of *Parkia biglobosa* under a greenhouse condition

Treatments	2	4	6	8	10	12	14	16
+Amf 0	9.75 ^{abc}	9.60 ^{a}	10.14 ^{a}	10.44 ^{b}	10.67 ^{bc}	13.94 ^{bc}	15.11 ^{bc}	15.11 ^{abc}
-Amf 0	10.5 ^{abc}	8.75 ^{a}	10.01 ^{a}	11.02 ^{b}	11.0 ^{bc}	11.33 ^{bc}	15.15 ^{abc}	15.05 ^{abc}
+Amf 10	11.50 ^{abc}	10.15 ^{a}	11.67 ^{a}	11.67 ^{b}	13.33 ^{abc}	13.33 ^{abc}	18.67 ^{abc}	16.75 ^{abc}
-Amf 10	10.05 ^{abc}	8.09 ^{a}	11.15 ^{a}	13.33 ^{b}	13.33 ^{abc}	14.1 ^{bc}	22.33 ^{abc}	17.70 ^{abc}
+Amf 20	11.50 ^{abc}	14.75 ^{a}	15.55 ^{a}	15.55 ^{b}	17.57 ^{abc}	19.00 ^{abc}	20.75 ^{abc}	21.25 ^{abc}
-Amf 20	11.75 ^{abc}	10.75 ^{a}	11.25 ^{a}	13.75 ^{b}	13.75 ^{bc}	12.25 ^{bc}	14.5 ^{bc}	18.75 ^{ab}
+Amf 30	11.00 ^{abc}	10.51 ^{a}	12.17 ^{a}	12.17 $^{a\ b}$	12.35 ^{abc}	15.22 ^{abc}	15.95 ^{abc}	19.43 ^{abc}
-Amf 30	10.75 ^{abc}	10.25 ^{a}	11.01 ^{a}	16.50 $^{a\ b}$	16.19 ^{bc}	23.33 ^{ab}	23.67 ^{abc}	27.98 ^{abc}
+Amf 40	11.50 ^{a}	11.75 ^{a}	14.33 ^{a}	21.89 ^{a}	23.29 ^{a}	26.12 ^{a}	26.41 ^{ab}	29.75 ^{abc}
-Amf 40	10.75 ^{abc}	11.98 ^{a}	13.66 ^{a}	13.87 ^{b}	16.70 ^{c}	22.25 ^{b}	25.10 ^{b}	29.7 ^{abc}

+*AMF* (inoculated with *Glomus clarum), -AMF (*un-inoculated)*, compost (0, 10* t ha-^{1},*20* t ha-^{1},*30* t ha-^{1},*40* t ha-^{1}

Table 5: Dry matter yield of the plant after harvesting

TREATMENT	LEAVES	STEM	ROOT
+Amf 0	1.27 [ab]	0.64 [a]	0.86 [ab]
-Amf 0	1.43 [a]	0.69 [a]	1.19 [ab]
+Amf 10	1.46 [abc]	0.63 [a]	1.41 [ab]
-Amf 10	0.85 [a]	0.49 [a]	1.69 [ab]
+Amf 20	1.12 [abc]	0.91 [a]	1.59 [ab]
-Amf 20	1.41 [a]	0.67 [a]	1.38 [ab]
+Amf 30	1.07 [bc]	0.71 [a]	0.76 [ab]
-Amf 30	1.53 [a]	0.59 [a]	0.94 [a]
+Amf 40	1.58 [ab]	1.00 [a]	1.76 [ab]
-Amf 40	1.15 [a]	0.31 [a]	1.61 [ab]

+AMF (inoculated with *Glomus clarum), -AMF (*un-inoculated)*, compost (0, 10* t ha-^{1},*20* t ha-^{1},*30* t ha-^{1},*40* t ha-^{1}

Table 6: Physical and chemical properties of the Postharvest soil.

Treatment	N (g/kg)	P mg/kg	K cmol/kg	Ca Cmol/kg	Mg cmol/kg	Na cmol/kg	Cu cmol/kg	O.C g/kg
+Amf 0	0.15	0.73	0.002	11.37	0.76	2.72	2.4	1.69
-Amf 0	0.15	3.85	0.002	14.17	1.11	3.13	3.7	1.78
+Amf10	0.15	12.53	0.002	10.78	0.93	2.44	3.3	1.76
-Amf 10	0.08	1.14	0.002	13.97	1.43	2.86	4.4	0.94
+Amf 20	0.13	11.31	0.002	10.57	0.76	2.30	2.8	1.49
-Amf 20	0.17	12.40	0.002	9.58	1.29	2.87	4.3	1.94
+Amf 30	0.05	0.37	0.003	11.38	0.96	2.80	3.0	1.39
-Amf 30	0.11	1.46	0.003	15.76	1.23	3.11	4.3	1.72
+Amf 40	0.12	1.79	0.003	12.57	1.39	3.09	3.0	1.50
-Amf 40	0.11	4.54	0.003	13.37	0.95	3.10	3.80	1.28

The analysis of the soil before and after the experiments could also be comparable to one another as no variation was observed. The application of mycorrhizal and compost boosted the mineralization of the soil after the amendments

Discussion

Chemical properties of soil and compost used

The soil pH value was slightly acidic, soil was moderately furnished with P content since the critical value of 8-20mg/kg (Sobulo *et al*., 1981). The soil was deficient in both potassium (K) and Nitrogen (N) content compared to the critical value of soil required which is at least 1.5g/kg for N (Adeoye and Agboola., 1985) and 0.20-0.40cmol/kg (Adeoye and Agboola., 1985).

Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and Compost on the plant height of *Parkia biglobosa* under a greenhouse condition

There was significant difference ($p<0.05$) in the plant height of *parkia biglobosa* between mycorrhizal and non-mycorrhizal plants across the weeks at 2WAT-14WAT, except at 16WAT, where there was no variation in mycorrhizal and non-mycorrhizal plants (Table 2). Compost application with the interaction of AMF at 40 t ha^{-1} recorded the highest height at 16WAT with 35.14cm and it is relatively comparable to other treatments used, the least plant height was observed when -AMF 0 was used as an amendment with 23.00cm. Among the non- inoculated plants, application of -AMF 10 produces the highest plant height 29.57cm while -AMF 0 had the least plant height with 23.00cm.

Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and compost on the collar diameter of *Parkia biglobosa* under a greenhouse condition.

Compost application with AMF interaction did not influence the increase of collar diameter as given in Table 3. However, at 10 WAT, mycorrhizal plants was significantly ($p<0.05$) different in collar diameter at +Amf 20 t ha^{-1} compared to non-mycorrhizal plants -Amf 10 t ha^{-1}. Application of compost at +Amf 40 t ha^{-1} produced significantly higher collar diameter when compared +Amf 20 t ha^{-1} with a mean value of 3.59mm and 1.18mm respectively. However, at 16WAT all the treatments are comparable to one another except + AMF 30t/ha which produced the lowest collar diameter with mean value of 2.97mm (Table 3)

Influence of Arbuscular Mycorrhizal Fungi (*glomus clarum*) and compost on the number of leaves of *Parkia biglobosa* under a greenhouse condition.

There was significant difference at 8, 10 and 12 WAT among inoculated plants at *40* t ha^{-1} and un-inoculated plants at *40* t ha^{-1} (table 4). Interaction of AMF and compost produces the highest leaves number at these significant weeks with mean value of 21.89, 23.29 and 26.12 respectively. At 2, 4 and 6 WAT there was no significant differences in all the treatments used. All treated pots were comparable to one another at both inoculated and un-inoculated treatments. This is similar to the results reported by Abdullahi and Sheriff (2013) that no significant difference ($p>0.05$) in number of leaves per plant due to mycorrhizal inoculation at 4 weeks after transplant (WAT) was observed. There was no significant difference ($p>0.05$) in number of leaves due to the compost application.(Table 4). However, at 16 WAT, interaction of AMF and compost 40 t ha-1 produced highest number of leaves with a mean value of 29.75 when compared with control at –AMF 0 t ha^{-1} (15.05)and –AMF 0 t ha^{-1}(15.11) but comparable with other treatments of compost rates. Similar result was reported by Yusif *et al*. (2016) who found no significant difference ($p>0.05$) in number of leaves among compost rates.

Dry matter yield of the plant after harvesting.

There was no variation in the dry matter yield of leaves and stem presented in table 5 above. However, The highest dry matter yield was recorded when Amf 40 t ha^{-1} was used as an amendment for the leaves, stem and root while the lowest dry matter yield was observed in -Amf 10 t ha^{-1} for leaves with a mean value of 0.85g, -Amf 40 t ha^{-1} for stem with a mean value of 0.31 and +Amf 30 t ha^{-1} for roots with a mean value of 0.76g. Mycorrhizal inoculated plants had significantly ($p<0.05$) higher shoot and leaves dry matter yields compared to non-mycorrhizal inoculated plants (Table 5). This could be attributed to the ability of mycorrhizal to improve absorption of nutrients. The result agrees with the findings of previous researchers including Al-Karaki *et al.* (1998) who reported increase shoot dry matter yields with mycorrhizal inoculation in wheat plants(*Triticum aestivum* L.). Shoot dry matter yields increased with increasing rate of compost application, with +Amf 40 t ha-1 of compost producing significantly ($p<0.05$) higher shoot dry matter yields. However, +Amf 40 t ha-1 of compost application rate was found to be comparable with +Amf10 and +Amf30 t ha-1 of compost application rates in shoot dry matter yields.

Physical and chemical properties of the Postharvest soil

The analysis of the soil before and after the experiments could also be comparable to one another as no variation was observed. The application of mycorrhizal and compost boosted the mineralization of the soil after the amendments. (Table 6).

Conclusion

Based on the description of results above, it can be concluded that: The Inoculation of the AMF and compost significantly affect the early growth performance of *parkia biglobosa*, thus providing optimum soil physical conditions for it growth.

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