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RESPONSE OF *PARKIA BIGLOBOSA* JACQ BENTH TO NPK AND *MYCORRHIZA* INOCULATION AT EARLY STAGE OF PLANTATION ESTABLISHMENT IN SUDAN SAVANNA OF NIGERIA

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ABSTRACT

Inadequate and low soil nutrients during trees specie establishment in their permanent fields is detrimental to growth and development of the species resulting to slow growth rate. *Mycorrhiza* and NPK inoculation can be used to enhance and hasten plant growth rate. To investigate the efficacy of *Mycorrhiza* and NPK inoculation at different levels on establishment of *Parkia biglobosa* in the permanent field, field trial was conducted during the rainy seasons. The experiment consisted of four treatments laid out in Complete Randomized Block Design (CRBD) and replicated three times; NPK 5 g plant^{-1} (Treatment A), *Mycorrhiza* 5 g plant^{-1} (Treatment B), NPK 2.5 g plus *Mycorrhiza* 2.5 g plant^{-1} (Treatment C) and control (Treatment D).The growth parameters measured were plant height, stem girth, number of branches and number of leaves. Data were collected at 2 weeks interval after application of treatments for 12 weeks. The data collected were subjected to analysis of variance (ANOVA). The result shows that *Mycorrhiza* and NPK (treatment C) at 12 weeks after transplanting was observed to have significantly influenced plant height (32.13 cm) and stem girth (7.43 cm) compared to the control treatment with plant height (27.43 cm) and stem girth (5.63 cm). Plant treated with *Mycorrhiza* produced significantly highest number of leaves (72) and number of branches (12) compared to other treatments. It was concluded that morphological growth of *Parkia biglobosa* can be enhanced by *Mycorrhiza* and NPK inoculation.

Keywords: *Mycorrhiza*, NPK, *Parkia biglobosa*, Plantation, Establishment

Introduction

Fertilization has been a major component of cultural practices in forestry and agricultural crop production for over a century in Nigeria, since most of the arable lands are under continuous cultivation (Igbokwe *et al.*, 2017). The savanna soil of Northern Nigeria is more or less completely weathered and possesses few mineral resources. They are low in organic matter, hence the need for fertilizer application if a significant production is to be maintained (Igbokwe *et al.*, 2017). Arbuscular*mycorrhiza* fungi (AMF) are obligate symbionts that colonize the roots of most cultivated plant species (Kumar *et al.*, 2007; Meddad *et al.*, 2010). *Mycorrhizal* symbiosis can be found in nearly all types of ecological situations and most plant species are able to form this symbiosis naturally (Jaizme *et al.*, 2006; Shukla *et al.*, 2012).

These associations occur naturally in the fields, favoring plant development by increasing nutrient uptake, growth rates and hormonal activities (Shukla *et al.*, 2010; Hashmi *et al.*, 2010; Jha *et al.*, 2012). The positive effects of mycorrhizae on seedlings survival and growth under nursery conditions are well documented (Smith *et al.*, 2009; Guissou *et al.*, 2016).

To develop any agroforestry/forestry model, healthy seedlings of woody perennials are pre-requisite (Jha *et al.,* 2015). When the nursery raised seedlings are transplanted, they may face transplantation shocks in the fields and consequently plants become weaker and poorly established (Naresh*et al.,* 2017). Navarro *et al.,* (2011) postulated that preconditioning of young seedlings with efficient AMF not only makes plant stronger but also helps in their establishment in fields. Early inoculation of seedlings with AMF can be beneficial in two ways. That is, superior and stronger growth of the seedlings, and better performance in the fields (Turjaman *et al.,* 2008).

Parkia biglobosa (Jacq. Benth) is an important indigenous multipurpose fruit tree (Oyebamiji *et al*., 2014; 2018). *Parkia* is popularly known as the African locust bean belonging to the family leguminosae-mimosoideae. It is known as dawadawa (Hausa), African locust beans (English), Igba/Iyere (Yoruba). The tree is known to be a native of Africa and it is an important multipurpose tree of West African Savannah land and one of the most common species of the parkland agro-forestry system (Oyebamiji *et al*., 2019). *Parkia biglobosa* is a perennial tree with a height ranging from 7 to 20 m, although it can reach 30 m under exceptional conditions. Its crown is large, spreads wide with branches low down on a stout bole; amber gum exudes from wounds; bark dark grey brown, thick, fissured. Leaves alternate, dark green, bipinnate to 30 cm long, pinnae up to 17 pairs with 13-60 pairs of leaflets, 8-30 mm × 1.5-8 mm, of distinctive shape and venation (Oyebamiji *et al*., 2019). Leaflets held on a long rachis. The fruit is a legume, slightly indented between the seeds at maturity. The seeds are embedded in a yellowish, mealy, sweet testing edible pulp (Aliero *et al.*, 2001).

Parkia biglobosa trees are the most prioritized woody component of the Nigeria Savanna parkland system because of their drought and fire resistance, and their culinary, therapeutic and industrial raw material values (Kio *et al.* 1989). In Nigeria, the tree is encountered in many savannah land uses, including improved fallow, silvopastoral system and homestead woodlots (Popoola and Tee, 2001). Moreover, *Parkia* trees are also such vital components of the ecosystem that have productive, protective and recreational functions (Atiku *et al*., 2013). They control soil erosion, stabilize regional and global climates; provide carbon sinks, and acts in pollution control. The extent to which this forest tree is being exploited calls for urgent attention and to resuscitate its biological diversity is the major focus of this study.

Materials and Method

Experimental Site

The experiment was conducted at Shelterbelt Research Station Kano, Forestry Research Institute of Nigeria. (Latitude 12^o 1’ 42.20” to 12^o 1’ 43.65” N and Longitude 8^o 30’, 9.06” to 8^o 30’ 29.07” E),

Seedlings Production

Seeds of *Parkia biglobosa* were collected from Yan’bawa village Makoda Local Government, Kano State. The seedlings were raised in the nursery of Shelterbelt Research Station Kano. At 12 weeks after sowing seedlings with almost the same heights, stems girth and number of branches were selected for this study.

Treatment and Experimental Design

The experiment was conducted using Complete Randomized Block Design (CRBD) with four treatments and three replications. The treatments were as follows: Control (A), NPK 5g (B), NPK

2.5g plus Mycorrhiza 2.5g (C) and Mycorrhiza 5g (D).

Data Collection

Data were collected at 2 weeks interval for 12 weeks on plant height, number of leaves, number of branches and stem girth plant^{-1}. The plant height was determined using meter rule, stem girth by digit Vernier caliper while the number of leaves and branches were determined by counting. The data collected were subjected to analysis of variance (AVONA) using GenStat and significant mean differences were separated by the used of Fishher's Protected LSD.

Results

Effect of *Mycorrhiza* and NPK on the Plant Height (cm) of *Parkia biglobosa*

The result presented in table 1 shows the effect of *Mycorrhiza* and NPK on the plant height (cm) of *Parkia biglobosa.* Although the performance of all the treatments is lower than when used in synergy, the plant height irrespective of the treatments used to increase steadily over the 12 weeks period. However, at 12 weeks after transplanting, treatment 'C 'recorded the highest plant height of 32.13 cm compared to treatment A, B and D. The least plant height of 15.00cm was recorded at 2 weeks after transplanting with treatment 'A' compared to treatment B, C and D.

Table 1: Effect of *Mycorrhiza* and NPK on the Plant Height (cm) of *Parkia biglobosa* in the Field

	WEEKS AFTER TRANSPLANTING					
TREATMENTS	**2 weeks**	**4 week**	**6 weeks**	**8 weeks**	**10 weeks**	**12 weeks**
A	15.00^{b}	18.27^{b}	21.13^{c}	26.67^{c}	27.43^{b}	27.43^{c}
B	15.40^{b}	20.60^{a}	24.00^{ab}	27.67^{b}	27.67^{b}	28.93^{b}
C	17.93^{a}	23.53^{a}	26.60^{a}	30.97^{a}	30.97^{a}	32.13^{a}
D	15.27^{b}	18.63^{b}	23.10^{b}	28.30^{ab}	28.30^{ab}	29.43^{b}
P - Level	0.011	<.001	<.001	<.001	<.001	<.001
SE±	0.438	0.247	0.304	0.142	0.320	0.336

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

A= Control, B= NPK, C= NPK + Mycorrhiza, D= Mycorrhiza

Effect of *Mycorrhiza* and NPK on the Number of Leaves of *Parkia biglobosa*

The result presented in table 2 showed the effect of *Mycorrhiza* and NPK on the number of leaves of *Parkia biglobosa.* Treatment 'D' recorded significantly highest number of leaves (72) at 12 weeks after transplanting compared to treatment A, B and C. The least number of leaves (30) was recorded at 2 weeks after transplanting with treatment 'A' compared to treatment B, C and D.

Table 2: Effect of *Mycorrhiza* and NPK on the Number of Leaves of *Parkia biglobosa* in the Field

	WEEKS AFTER TRANSPLANTING					
TREATMENTS	**2 weeks**	**4 weeks**	**6 weeks**	**8 weeks**	**10 weeks**	**12 weeks**
A	30.00[b]	32.00[c]	42.00[c]	41.00[c]	51.00[c]	57.00[c]
B	39.00[a]	33.00[c]	34.00[d]	32.00[d]	36.00[d]	44.00[d]
C	40.00[a]	41.00[b]	45.00[b]	55.00[b]	55.00[b]	59.00[b]
D	39.00[a]	49.00[a]	54.00[a]	67.00[a]	70.00[a]	72.00[a]
P - Level	0.197	<.001	<.001	<.001	<.001	<.001
SE±	3.210	0.726	2.460	2.810	2.090	2.413

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

Effect of *Mycorrhiza* and NPK on the number of branches of *Parkia biglobosa*

The result presented in table 3 shows the effect of *Mycorrhiza* and NPK on the number of branches of *Parkia biglobosa*. Treatment A and D recorded significantly highest number of branches at 12 weeks after transplanting compared to treatment B and C.

Table 3: Effect of *Mycorrhiza* and NPK on the Number of Branches of *Parkia biglobosa* in the field

	WEEKS AFTER TRANSPLANTING					
TREATMENTS	**2 weeks**	**4 weeks**	**6 weeks**	**8 weeks**	**10 weeks**	**12 weeks**
A	7.00[b]	9.00[a]	10.00[ab]	10.00[ab]	12.00[a]	12.00[a]
B	7.00[b]	9.00[a]	9.00[b]	9.00[b]	9.00[b]	8.00[c]
C	9.00[a]	10.00[a]	11.00[a]	10.00[ab]	9.00[b]	10.00[b]
D	8.00[ab]	10.00[a]	11.00[a]	11.00[a]	12.00[a]	12.00[a]
P - Level	0.189	0.696	0.138	0.226	0.054	0.037
SE±	0.645	0.816	0.764	1.247	1.067	0.816

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

A= Control, B= NPK, C= NPK + Mycorrhiza, D= Mycorrhiza

Effect of *Mycorrhiza* and NPK on Stem Girth of *Parkia biglobosa*

The result presented in table 4 shows theEffect of *Mycorrhiza*and NPK on the stem girth of *Parkia biglobosa*. The stem girth of *Parkia biglobosa* increases as the number of week's increases in all the treatments. Treatment 'C' recorded significantly highest stem girth of 7.43 mm at 12 weeks after transplanting compared to treatment A, B and C while the lowest stem girth of 2.88 was recorded in plant with treatment A at 2 weeks after transplanting compared to treatment B, C and D.

Table 4: Effect of *Mycorrhiza*and NPK on the Stem Girth of *Parkiabiglobosa*in the Field

	WEEKS AFTER TRANSPLANTING					
TREATMENTS	**2**	**4**	**6**	**8**	**10**	**12**
A	2.88[d]	4.48[a]	5.21[a]	5.33[b]	5.36[b]	5.63[b]
B	3.14[b]	3.57[b]	3.95[b]	4.33[c]	4.36[c]	5.57[b]
C	3.99[a]	4.45[a]	5.42[a]	6.26[a]	6.91[a]	7.43[a]
D	3.01[c]	4.01[b]	4.79[a]	4.93[c]	5.00[b]	5.00[b]
P - Level	<.001	0.003	0.003	<.001	<.001	<.001
SE±	0.026	0.106	0.174	0.003	0.072	0.072

Means followed by the same letter(S) are not significantly different at 5% level of significance using Fisher's LSD.

A= Control, B= NPK, C= NPK + Mycorrhiza, D= Mycorrhiza

Discussion

Tree species varied in their nutrients requirements and inclination as such effort must be made to assess the appropriate nutrient preference of any tree species for enhanced growth and development. According to Muktar *et al.*, 2021, the genetic characteristics of any plant determine its nutritional uptake and manipulation for growth. *Parkiabiglobosa*used in this study is a multipurpose fruit tree species commonly grown in orchards and agroforestry systems under the arid and semi-arid climatic conditions of West Africa. They usually grow on soils characterized by low organic matter concentration with reduced available P, making them ideal candidates for testing the potential practical applications of NPK and *Arbuscular Mycorrhizal* inoculation.

The results of study showed that NPK and *Mycorrhiza* treatments (either individual or combined inoculation) increased growth of the test plant species when compared with control treatment. This could be due to more volume of soil exploration for available nutrients and water by *Mycorrhizal* plants than non-*Mycorrhizal* plants. Better nutrients, especially phosphorus and water uptake by *Mycorrhiza* inoculated plants generally leads to secondary indirect effect such as improved plant biomass (Jha *et al.*, 2012; Shukla *et al.*, 2012). Beneficial effects of *Mycorrhizal* inoculation on growth and health of various plant species, including *Parkia* species have been reported by several researchers (Manjunath *et al.*, 1989; Guissou *et al.*, 1998; Schneider *et al.*, 2013; Verma *et al.*, 2015).

The higher growth in plant height and stem girth obtained with *Mycorrhiza* and NPK treatment than with control could be attributed to the ability of *mycorrhiza* to extends plant root system's capacity to explore more water resources in the soil and to cope with stress situations (Mathur and Vyas,2000, Manoharan,2010)and this issimilar also to the findings of Naresh *et al.* (2017) who worked on the effect of *ArbuscularMycorrhiza* on early seedlings growth of some multipurpose tree species. Furthermore, prophylactic effects have been reported, proving in many situations that *Mycorrhiza* can act as biological control agent by lessening proliferation and damage caused by pests, insects and soil borne diseases leading to healthier and vigorous plant growth and development (Jung *et al.*, 2012).

Conclusion

Based on the findings of the research work, it can be concluded that the application of *Mycorrhiza* and NPK plays an important role in the improvement of growth in the establishment of *Parkia biglobosa* in the field.

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