IJABR Vol. 6(1): 45 -53 (2014)

Original Article

INFLUENCE OF MYCORRHIZA INOCULATIONS AND NPK FERTILIZER APPLICATION ON GROWTH OF GUM ARABIC [*Acacia Senegal* (L.)] WILD IN A NURSERY

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Submitted:May 02, 2014; Accepted: June 06, 2014; Published: June 30, 2014.

ABSTRACT

A natural population of *Acacia senegal* which is becoming low, has been traced to poor seedling growth. The influence of NPK fertilizer and mycorrhiza inoculations on some morphological parameters and early growth of *A. senegal* in the semi-arid region of Nigeria was investigated. The results obtained with NPK fertilizer application were significantly higher ($p<0.05$) with plant height of 46.8cm, collar diameter of 2.73mm, chlorophyll content of 28.81mg/l, root length of 16.38cm and leaf number of 36. Comparatively, the results obtained from the seedlings inoculated with mycorrhizae had significantly lower ($p<0.05$) values with plant height of 48.48cm, collar diameter of 2.36mm, chlorophyll content of 28.56 mg/l and leaf number of 32. These values were significantly higher than the control with 45.52cm, 2.26mm, 26.97mg/l and 27 leaves respectively. The results obtained from seedlings treated with 5g NPK fertilizer were significantly higher ($p<0.05$) than those without NPK fertilizer and those seedlings with 10g of fertilizer application. Also, the seedlings inoculated with endomycorrhiza was significantly higher ($p<0.05$) than those inoculated with ectomycorrhiza. The application of NPK fertilizer at 5g per pot

of the seedlings and the inoculation with endomycorrhiza are recommended as they enhanced the best morphological parameters of *Acacia senegal* in the nursery beds.
Key words: Chlorophyll content, Mycorrhiza, NPK Fertilizer, Morphological parameters.

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INTRODUCTION

Acacia Senegal (L.), commonly called gum-arabic, is a multi-purpose plant mostly found wildly in the drier parts of the world (Anon, 1986). Today, it is grown primarily for production of gum-arabic; it plays a secondary role in agricultural systems, restoring soil fertility and providing fuel and fodder (Hocking, 2003). An estimate of 17,000 tons of gum-arabic is produced in Nigeria annually; the second largest productionin Africa after Sudan (Folorunsho et al., 2002). *A. Senegal* is endowed with features that give it potenetials for ecosystem stabilization, anti-desertification and for production of high quality gum-arabic (Awodola and Okoro, 1986). In recent years, high trade in gum-arabic and other uses of the species threatened its natural population (Folorunsho *et al.*, 2002). Poor yield of the species in the semi-arid region of Nigeria maybe attributed to inadequate physiological and silvicultrual information regarding the species. Most soils in semi-arid zones are marginal and deficient in Nitrogen and Phosphorus, which are principal elements required for plant growth and development (Shinkafi, 2000). Since poor growth performance of the species on the field is a major constraint to high yield in the semi-arid region, identifying efficient nursery management practice through adequate supply of water and other essential nutrient supply mechanism is crucial.

The objective of this study was therefore to investigate the influence of mycorrhizae inoculations and NPK fertilizer application on the early growth of *A. senegal* in the nursery of a semi-arid region of Nigeria.

MATERIALS AND METHODS

The study was conducted in a screen house at the Botanical garden of Usmanu
Danfodiyo University, Sokoto, Nigeria. Sokoto lies in the North-Western Nigeria in the Sudan Savanna vegetation zone. It is located between latitudes $11^0$30' and $13^0$50'N and longitudes 4^0 to 6^0E (Ogigirigi, 2004).

Seeds of *A. senegal* were collected from pure stands in Gada, in Gada local government area of Sokoto state, Nigeria. The seeds were dried for a week at room temperature and stored at a temperature of 4^oC before experimentation.

Crude inoculums of *Suillus grevillei* (ectomycorrhiza) and *Boletus sp.* (endomycorrhiza) inoculants, used in this study, were obtained from the

International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The culture was prepared following the procedure of Osunubi and Mulongoy (1991) and the exology of Sokoto did not affect the performance of the mycorrhizae.

Experimental Design

Standard plastic pots (25 x 15cm) with drainage holes at the bottom were filled with 4.0kg of sterilized sandy-loam soil which were irrigated with distilled water just before planting. Thereafter, three viable seeds of *A. senegal* were sown in each pot. Then, mycorrhiza and NPK were applied as detailed in the treatments.

Treatments consisted of factorial combination of 3 NPK levels (0, 5g and 10g) and 3 inoculation level (no mycorrhiza, ectomycorrhiza and endomycorrrhiza) layed out in a completely randomized design with five replicates per treatment. The polypots were then distributed into nine experimental treatments and labelled as follows:

NMFO = No mycorrhiza and no NPK fertilizer
NMF5 = No mycorrhiza and 5g NPK fertilizer
NMF10 = No mycorrhiza and 10g NPK fertilizer
EcMFO = Ectomycorrhiza and no NPK fertilizer
EcMF5 = Ectomycorrhiza and 5g NPK fertilizer
EcMF10 =Ectomycorrhiza and 10g NPK fertilizer
EnMFO = Endomycorrhiza and no NPK fertilizer
EnMF5 = Endomycorrhiza and 5g NPK fertilizer
EnMF10 = Endomycorrhiza and 10g NPK fertilizer

10g of the ecto- and endomycorrhiza were applied in a circle of 4cm radium and 1cm deep under the seeds of *A. senegal* sown in the respective pots. Simultaneously, 5g and 10g of NPK fertilizer were also mixed with the sterilized soil. The Control experiments were those pots not treated with ecto- and endomycorrhiza nor NPK fertilizer. The polypots were watered every alternate day with watering-can for 20 weeks, for morphological parameters. The plant height was measured with meter rule, leaf number by physical count and chlorophyll content was determined using spectrophotometer method (Chang and Troughton, 2007) while collar diameter and root length were measured with vernier callipers and meter rule, respectively.

Statistical Analysis

Data obtained from all the variables in the investigation were subjected to analysis of variance (ANOVA) using AGRES statistical package. Significant difference in the treatments was further subjected to Duncan's Multiple Range Test (DMRT) for the separation of treatment means.

RESULTS

The combined effect of NPK fertilizer application and mycorrhiza inoculation on plant height, leaf number, collar

diameter, root length and total chlolrphyll content of the seedlings of *Acacia senegal* in the nursery is shown in Tables 1, 2, 3, 4 and 5 respectively.

At 4, 8, 12, 16 and 20 weeks after planting (WAP), the plant height and number of leaves varied in response to NPK fertilizer and mycorrhiza inoculation. The plant height, collar diameter and number of leaves of seedlings inoculated with mycorrhiza were higher than uninoculated seedlings(control). At 20 WAP, the root length of the seedlings inoculated with endomycorrhiza and 5g of NPK fertilizer application was significantly higher ($p<0.05$) than the seedlings inoculated with ectomycorrhiza and those not inoculated with mycorrhiza (Table 5). Table 4 shows that the chlorophyll content of seedlings inoculated mycorrrhizae was greater than the non-inoculated seedlings (control). The endomycorrhiza inoculated seedlings gave a higher chlorophyll content and number of leaves than the ectomycorrhiza inoculated seedlings. The seedlings inoculated with mycorrhiza have improved growth more than the non-inoculated seedlings. It was also observed that the growth response of *A. senegal* was better than endomycorrhiza than the ectomycorrhiza. Generally, the combined effect of NPK fertilizer application and mycorrhiza inoculation shows that seedling treated with endomycorrhiza and 5g dose of NPK fertilizer have higher growth than seedlings that were inoculated with ectomycorrhiza and treated with 10g dose of NPK fertilizer.

DISCUSSION

The application of different doses of NPK fertilizer and mycorrhizae inoculations whether ecto- or endo-mycorrhiza were found to have significant ($p<0.05$) influence on the growth of *A. senegal*. This is in conformity with the observations made by Nelson and Safir (1982), Jasper *et al*. (1989) and Shinkafi (2000) that interaction between NPK fertilizer and mycorrhiza fungi increased plant productivity by improving Phosphorus and Nitrogen nutrition.
Momoh and Gbadegesin (1985) and Joshi and Dhar (2003) also reported that interaction between mycorrhiza, Phosphorus and Nitrogen is favourable to inoculation and biological nitrogen fixation in legumes.

It was observed that the seedlings of *A. senegal not* treated with any mycorrhiza but with 5g of NPK had the highest number of leaves. This result agrees with the work of Awodola and Nwoboshi (1993) who reported that the level of nitrogen supply significantly affected the number of leaf of *Parkia biglobosa* seedlings. Similarly, Ajala and Ahmed (1994) reported that different levels of Nitrogen were found to be highly significant in the growth of *Beta vulgaris.* The collar diameter of the *A. senegal* seedlings treated with endomycorrhiza and 5g of NPK was significantly higher ($p<0.05$) than

those of seedlings from all other treatments. This observation is in conformity with the works of Awotoye *et al*. (1992) and Shinkafi (2000) who noted that the combination of mycorrhiza and NPK had significant effect on the growth of woody legumes.

The total cholorophyll content of the seedlings of *A. senegal* treated with ectomycorrhiza and 10g of NPK was significantly higher than other treatments applied and the content gradually increased with the age of the seedlings. These findings agreed with the work of Shinkafi (2000) and Bello (2005) who reported that mycorrhiza inoculation and NPK application enhanced total chlorophyll content of *A. albida* and *A. senegal* respectively.

Root length of the seedlings does not require the combined application of NPK fertilizer and mycorrhiza inoculation. It was the application of endomycorrhiza alone that had profound influence on the root development of the plant. This is in conformity with the works of Jasper *et al*., (1992) and Shinkafi (2000) that endomycorrhiza was observed to promote the development of roots of *Acacia nilotica*, *Parkia biglobosa* and *Faidhaerbia albida,* respectively.

Table 1: Effect of NPK fertilizer and Mycorrhizae on height of *Acacia senegal* seedlings at different weeks after planting (WAP).

Fertilizer (NPK)	Mycorrhiza inoculation	Plant height (cm) 4 WAP	8 WAP	12 WAP	16 WAP	20WAP
No NPK	No mycorrhiza	11.90^{j}	20.66^{i}	28.46^{h}	36.76^{f}	45.52^{c}
NPK 5g	"	13.84^{j}	21.94^{i}	30.70^{g}	38.08^{e}	46.84^{b}
NPK 10g	"	11.28^{i}	19.82^{i}	26.96^{e}	32.84^{e}	39.98^{g}
No NPK	Ectomycorrhiza	11.94^{j}	20.74^{c}	28.80^{g}	36.88^{c}	43.04^{e}
NPK 5g	"	13.48^{j}	22.60^{i}	30.84^{g}	38.82^{e}	46.80^{b}
NPK 10g	"	11.54^{i}	20.80^{i}	29.54^{g}	35.30^{d}	41.06^{f}
No NPK	Endomycorrhiza	12.54^{j}	21.60^{i}	30.84^{g}	38.58^{e}	46.32^{b}
NPK 5g	"	13.88^{j}	21.60^{i}	31.52^{g}	39.50^{e}	48.48^{a}
NPK 10g	"	11.78^{i}	20.30^{i}	28.42^{h}	36.48^{f}	44.54^{d}
S.E.		0.15	0.23	0.27	0.29	0.31

Means in a column followed by the same letter(s) are not significantly different using DMRT at 5% level

S. E: Standard error

Table 2: Effect of NPK fertilizer and Mycorrhizae inoculation on leaf number *Acacia senegal* seedlings at weeks after planting (WAP).

Fertilizer (NPK)	Mycorrhiza inoculation	Leaf number 4 WAP	8 WAP	12 WAP	16 WAP	20WAP
No NPK	No mycorrhiza	7^{m}	12^{l}	17^{j}	22^{h}	27^{f}
NPK 5g	"	8^{m}	14^{k}	18^{i}	24^{g}	30^{c}
NPK 10g	"	6^{n}	12^{l}	16^{i}	22^{h}	28^{d}
No NPK	Ectomycorrhiza	7^{m}	13^{l}	19^{i}	23^{j}	29^{d}
NPK 5g	"	8^{m}	15^{k}	22^{h}	25^{g}	32^{b}
NPK 10g	"	6^{n}	12^{l}	18^{f}	22^{h}	29^{d}
No NPK	Endomycorrhiza	7^{m}	14^{k}	20^{i}	24^{g}	29^{d}
NPK 5g	"	8^{m}	15^{k}	23^{h}	30^{l}	36^{a}
NPK 10g	"	7^{m}	15^{k}	21^{i}	27^{f}	30^{c}
S. E.		0.6	0.8	0.6	0.6	0.6

Means in a column followed by the same letter(s) are not significantly different using DMRT at 5% level. S. E : Standard Error

Table 3: Effect of NPK fertilizer and Mycorrhizae inoculation on collar diameter (mm) of *Acacia senegal* seedlings at weeks after planting (WAP)

Fertilizer (NPK)	Mycorrhiza inoculation	Leaf number 4 WAP	8 WAP	12 WAP	16 WAP	20WAP
No NPK	No mycorrhiza	0.69f	1.12e	1.88d	1.98c	2.26c
NPK 5g	"	0.75f	1.14e	1.93c	2.11d	2.34c
NPK 10g	"	0.65f	1.11e	1.56g	1.99c	2.23c
No NPK	Ectomycorrhiza	0.69f	1.12e	1.90c	2.16d	2.31c
NPK 5g	"	0.73f	1.13e	1.94c	2.21c	2.36c
NPK 10g	"	0.66f	1.12e	1.62f	2.00d	2.19d
No NPK	Endomycorrhiza	0.71f	1.14e	1.94c	2.15d	2.54b
NPK 5g	"	0.75f	1.15e	1.98c	2.18d	2.73a
NPK 10g	"	0.69f	1.12e	1.88d	2.14d	2.69a
S. E.		0.01	0.05	0.02	0.03	0.09

Means in a column followed by the same letter(s) are not significantly different using DMRT at 5% level.

S.E : Standard Error

Table 4: Effect of NPK fertilizer and Mycorrhizae inoculation on total chlorophyll content (mg/l) of *Acacia senegal* seedlings at different weeks after planting (WAP).

Fertilizer (NPK)	Mycorrhiza inoculation	Leaf number 4 WAP	8 WAP	12 WAP	16 WAP	20WAP
No NPK	No mycorrhiza	23.67^{e}	26.15^{c}	26.37^{c}	26.66^{c}	26.97^{c}
NPK 5g	"	25.19^{d}	27.62^{b}	27.89^{b}	28.18^{a}	28.55^{a}
NPK 10g	"	25.71^{d}	27.86^{b}	27.97^{b}	28.23^{a}	28.38^{a}
No NPK	Ectomycorrhiza	24.02^{d}	26.39^{c}	26.64^{c}	27.05^{b}	27.38^{b}
NPK 5g	"	25.39^{d}	25.56^{d}	27.90^{b}	28.37^{a}	28.81^{a}
NPK 10g	"	25.99^{d}	28.21^{a}	28.39^{a}	28.71^{a}	28.65^{a}
No NPK	Endomycorrhiza	23.82^{e}	25.56^{d}	26.32^{c}	26.98^{c}	27.09^{b}
NPK 5g	"	25.67^{d}	27.65^{b}	28.01^{a}	28.15^{a}	28.56^{a}
NPK 10g	"	26.91^{c}	27.97^{b}	28.34^{a}	28.56^{a}	28.73^{a}
S. E.		0.16	0.13	0.13	0.11	0.11

Means in a column followed by the same letter(s) are not significantly different using DMRT at 5% level.
S. E: Standard Error

Table 5: Effect of NPK and Mycorrhizae inoculation on root length (cm) of *Acacia senegal* seedlings at harvest (20 WAP).

Fertilizer (NPK) treatment	Mycorrhiza inoculation	Root Length (cm)
No NPK	No mycorrhiza	14.47^{d}
NPK 5g	"	15.85^{b}
NPK 10g	"	13.68^{e}
No NPK	Ectomycorrhiza	14.65^{d}
NPK 5g	"	15.96^{b}
NPK 10g	"	14.56^{d}
No NPK	Endomycorrhiza	15.99^{b}
NPK 5g	"	16.38^{a}
NPK 10g	"	15.37^{c}

Means in a column followed by the same letter(s) are not significantly different using DMRT at 5% level.

CONCLUSION

It is evident from the results of this study that mycorrhizae inoculation especially endomycorrhiza, is essential for a healthy and adequate growth of the seedlings of *A. senegal* in the nursery. It can also be concluded that the application of NPK fertilizer at 5g dose rate per pot of the seedlings of *A.*

senegal in the nursery has enhanced better growth effect on the seedlings.
The use of mycorrhizae, particularly the endomycorrhiza and 5g dose of NPK fertilizer should be extended to our farmers. This treatment could be employed in the nursery to minimize the persistent high mortality rate experienced over the years on the nursery beds and on the field in the semi-arid zones.

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