Field Establishment of *Azadirachta indica*, *Dalbergia sissoo* and *Khaya senegalensis* in Kondowa Forest, South Darfur State, Sudan

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ABSTRACT

This study was conducted in Kondowa Forest Reserve in South Darfur State during August − October 2010 to compare the establishment of *Azadirachta indica*, *Dalbergia sissoo* and *Khaya senegalensis* by seedlings under rainfed conditions. An experiment was executed as randomised complete block design with three replicates. Statistical analysis of measured growth parameters showed significant differences in shoot length and highly significant differences in stem diameter at root collar: The results showed the superiority of *Dalbergia sissoo* in survival rate under the prevailing conditions: 100%, 91% and 87% for *Dalbergia sissoo*, *Azadirachta indica* and *Khaya senegalensis,* respectively. The average shoot length was 10.8 cm, 9.1 cm and 8.7 cm for *Dalbergia sisso*, *Azadirachta indica* and *Khaya senegalensis*, respectively. The average diameters at root collar were 3.4 cm for *Dalbergia sissoo*, 3.0 cm for *Azadirachta indica* and 2.6 cm for *Khaya senegalensis*. The average root lengths were 25.7 cm for *Dalbergia sissoo*, 21.4 cm for *Azadirachta indica* and 22.0 cm for *Khaya senegalensis*. The three species gave satisfactory establishment, thus encouraging their adoption for future planting programs in the reserved forest and surrounding habitats. Future investigations will be useful for large scale planting.

Key words: *Azadirachta indica*; *Dalbergia sissoo*; *Khaya senegalensis*

INTRODUCTION

Kondowa forest lies to the south east of Nyala (11 59° -12 01°) north. .It was reserved since 15th of June (1955 gazette number 882). Soil formation is dominated by basement complex overlain with shallow clay loam and sandy clay loam. The local climate is semi-arid zone, low rain full woodland and high rain full woodland of savannas zone with a mean annual rain fall of 416 mm and mean temperature of 29.1°. Natural vegetation is dominated by Acacia *albida*, *Acacia nilotica, Acacia tortilis, Azadirachta indica, Balanites aegyptiaca.* Within the forest, the following species: *Cassia siame*a, *Dalbergia sissoo, Khaya senegalensis, Hyphaene thebaica, Tamarindus indica, Ziziphus*

spina Christi, Calotropis procera, Eucalptus microtheca were established in the past, but most of these has been cut for refugee camps and security and provision of local wood consumption due to increase in the numbers of refugees into the near Kalma displaced peoples camp. Traditional agriculture and animal rearing are practised by the local population who also cut trees for firewood, charcoal production and household construction. Subsequently the forest area was subdivided into a number of plots and rented to local farmers for 500 pounds per Feddan to cultivate different crops on condition that tree seedling are planted with crops. This program was initiated since 2007 but the program of tree planting was not satisfactory.

It is crucial that the forest area be reforested as soon as possible to meet the multi-purpose function of trees in the region. Sudan is seriously affected by land degradation and desertification as reported in Great Green Well manifesto 2011. Hence, the inclusion of this program which was supervised by Forest National Corporation (FNC) under the support of the European Union and United Nations agencies.

Objectives:
A- To investigate relative performance of three tree species under the prevailing conditions in Konodwa forest.
B- To select the suitable species for the reforestation of Konodwa forest and similar sites.
C- To initiate research which will enhance afforestation and reforestation for protection and combating desertification?

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MATERIAL AND METHODS

The materials of this study were three indigenous tree species viz:
A- *Azadirachta indica* (Neem).
B- *Delbergia ssisso* (Sisso).
C- *Khaya senegalenssis* (Mahogany).
All these trees had been component of Kondowa forest in the past hence they are suitable for reforestation.

A- ***Azadirachta indica*** (**A.** Juss) local name as Neem.
Neem is indigenous to India but naturalised in Sudan. It can grow in tropic and subtropics regions. The species is drought tolerant and thrives in many of the drier areas of the world.

B- ***Dalbergia Sissoo***:
Dalbergia sissoo (Leguminosae, subfamily Papilionoideae) is a medium to large deciduous tree with a light crown. It is indigenous to India but has been introduced to

Sudan. Sissoo is a desirable shade tree in tropic and subtropics regions. Many medicinal uses are reported for its fresh leaves, dried bark and wood rasping from its native region.

Khaya senegalensis (desr, A. Juss) Meliaceae

Common name is mahogany. It is important multipurpose tree in its natural range in sub-Saharan Africa. It is particularly valued for timber, fuel wood and medicinal purposes as well as being a popular shade and amenity tree.

Method

Seeds were collected from West and South Darfur State and sow at FNC nursery in Nyala town. In the nursery, the cultural practices were implemented. Soil mixture was sand and clay at 1:1 ratio by volume then packed into 10 x 20 cm polythene bags punctured at the lower two-third. Then the bags were arranged in seedling beds and flood irrigated in such a way that the soil is wetted by imbibitions. Irrigation frequency was every other day at the beginning and then reduced to twice and a week gradually. Weeding and singling were done after seedlings emergence to a reasonable height approximately 10 cm at three months old. Then root pruning was done when the seedlings attained 15 cm height. Seedlings were then transferred to the field after seven months from sowing and planted in a randomized complete block design.

Experimental Description
Experimental Design

The experimental design is a Randomized Complete Block Design (RCBD) with three blocks (replications). The size of each block was 768 m² (16 X 48 m). Thus, the total area of the experimental plot was 2304 m² (3 blocks X 786 m²). Furthermore, each block is consisted of 3 sub-blocks. Hence, the total number of plots in the whole experimental area was 9 plots (3 X 3 blocks). Each block consist of three plots and the treatment in each plot was randomly assigned to each species.

Experimental lay-out

The experimental plot consisted of 5 rows spaced 4 m apart. Each row consisted of five trees at 4 m a part (5 rows X 5 trees = 25 trees per plot) . The total number of seedlings in the whole experimental area were 75 seedlings in three blocks = 225 seedlings.

Seedlings parameters

a- Survival percentage was calculated by accounting the number of live seed to the total seedlings planted as percentage. The mean for the block was then computed for three blocks.

b- Seedlings height was measured by a ruler to the nearest centimetre for all the plots and the average was computed.

c- Root collar was measured by ordinary sewing third to nearest millimetre.

RESULTS AND DISCUSSIONS

Survival percentage

After three months, the highest mean survival percent (100%) was recorded by *Dalbergia sissoo* followed by *Azadirachta indica* (91%) and *Khaya senegalensis* (87%). From the above results, *Dalbergia sissoo* and *Azadirachta indica* had the highest survival percentage than *Khaya senegalensis* (Table 1). Low survival rate in *Khaya senegalensis* is attributed to termites attack

Seedlings height

The final measurement of October showed significant differences, *Dalbergia sissoo* was significantly higher than *Azadirachta indica* and *Khaya senegalensis*. The final seedling height of the three species is 12.2 cm, 9.7 cm and 9.3 cm (Table 2).

Root Collar Diameter

Dalbergia sissoo gave a significantly greater stem compared to *Azadirachta indica* (Table 3). Significant differences in diameter were also observed between *Khaya senegalensis* and Azadirachta *indica* . Generally, *Dalbergia sissoo* had higher diameter compared to the other two species.

CONCLUSIONS

Although the trials were still young (11months) when last assessed, it is tentatively conduced that all the three species established well in the field. *Dalbergia sissoo* and *Azadirachta indica* were fast growing relative to *Khaya senegalensis*.
Dalbergia sissoo and *Azadirachta indica* gave good height growth and survival rate: *Khaya senegalensis* gave poor height growth, but it developed a deep tap-root, which is important in afforestation. In addition to fast growth, *Dalbergia sissoo* has a good survival percentage, long deep root and large diameter.

RECOMMENDATIONS

The tree species tasted gave satisfactory establishment. This encourages their adoption for future planting programs in reserved forest and surrounding habitats. Further investigations would be useful for large scale planting. Based on the root length, shoot height and root collar diameter, it is recommended that the following species can be selected for afforestation and reforestation programs in the following order of preference.

1-Dalbergia sissoo

2-Khaya senegalensis

3-Azadiracta indica

Further research is to continue for selection of species and provenances for different field condition in low rainfall areas.

Table 1. Survival percentage of three species at Kondowa forest

species	August	September	October	Average
A. indica	95.5%	91%	88.5%	91%
D. sissoo	100%	100%	100%	100%
Kh. senegalensis	96%	87%	79.2%	87%

Table 2. Seedling height (cm) of three species at Kondowa forest

Species	A .indica	D. sissoo	Kh. senegalensis
August	8.50	9.00	8.00
September	9.10	11.1	8.80
October	9.70	12.2	9.25

Table 3. Root Collar Diameter (cm) of three species at Kondowa forest

Treatments	August	September	October
A. indica	2.14 a	2.93 b	3.93 b
D. sissoo	2.09 a	3.11 a	4.86 a
Kh. senegalensis	1.87 b	2.61 c	3.25 c
CV%	3.27	2.34	4.19
LSD	0.15	0.15	0.38
Prob.	0.03	0.004	0.001