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ADAPTATION AND GROWTH PERFORMANCE EVALUATION OF AGROFORESTRY TREE SPECIES UNDER DIRE DAWA CONDITION, EASTERN ETHIOPIA

Musa Abdella[a] and Bira Cheneke[b]

a. Fedis Agricultural Research Center, Harar, Ethiopia.
b. Oromia Agricultural Research Institute, Ethiopia P.O. Box 81265, Addis Abeba.
Corresponding Author's Email: **musaabdellah345@gmail.com**

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Abstract: The study was conducted for three years (June 2016 - June 2019) to evaluate their adaptability of five agro forestry tree species: *Sesbania sesban, Moringa oliefera, Gravilea robusta, Azadarichta indica and Leuceana leucocephala* at Dire Dawa Administration Adada kebele, Eastern Ethiopia. The experiment was laid out in RCBD with three replications. The selected tree species had no problem on survival and adaptability at the study area except some growth variation and the outcome had a significant value at ($p<0.05$) between treatment's parameters. *Moringa oliefera* showed the highest performance followed by *Azadarichta indica, Sesbania sesban* and *Leuceana leucocephala* in terms of survival rate, height growth, root collar diameter and diameter at breast height at adada kebele. After three years of establishment, *Moringa oliefera, Azadarichta indica, Sesbania sesban*and *Leuceana leucocephala* showed the highest average mean survival rate with 90%, 88.55%, 82.78% and 82.11% respectively, at the study area. Hence it can be inferred that the conditions of Dire Dawa Administration matched with the environmental requirement of those tree species. On the other hand, species of *Gravilea robusta* showed lowest performance. Thus, the long dry season, which extended from eight to ten months in the study area, clearly explains the poor survival and growth response in some of the species. Generally, the study under Dire Dawa condition and related agro ecology, we advocate these adapted species and properly allocate species into the site that grow and adapt well for further agroforestry practices at wider scale on which success of agroforestry practices and forest plantations depend.

Keywords: Dire Dawa; Agroforestry; Height growth; Root collar diameter; Survival rate.

Postal Address: Fedis Agricultural Research Center, Harar, Ethiopia, P. O. Box 904, Harar, Ethiopia. Tel.: +251-256663225/7549

INTRODUCTION

Land degradation of the Ethiopia is a major problem due to a number of factors. One of the important causes is the removal of forest and vegetative cover as a result of increased human population leading to high demand for forest products and land for expanding the agricultural activities (Demel *et al.,* 2001). Eastern Ethiopia particularly, Dire Dawa Administration is well known by vegetation cover and most of the surrounding area is covered by forests comprised of a rich mixture of woody species (Abebe *et al.,* 2000). In spite of the importance of forest ecosystem to the livelihoods of the people in the area, the forest is dwindling from time to time due to high exploitation of woody and non-woody products. Rapid deforestation caused by an escalating demand for fuel wood expansion for agriculture has brought an ever-increasing

pressure on native woodland species (Mebrate *et al.,* 2004). If no remedial action is taken, this will cause severe impact on agricultural productivity leading to energy poverty and environmental degradation. Frequent and severe droughts often present a serious threat for millions of lives (Brockerhoff, 2008), which have occurred once in a decade in the 1970s and 1980s. Shortages of animal feed and biomass energy are also such an unsustainable use of natural resources. Agro forestry system has much potential for supplying fodder, poles, farm equipment, fuel wood and agricultural improvements (Abebe, 2000).

Multipurpose tree and shrubs species (MPTS) play a considerable role in addressing such multifaceted demands in the mixed crop-livestock production system (Betre *et al.,* 2000). They have the ability to fit into the farming system to be used as a source of manure, mulch, soil conservation, forage, fuel wood, farm implements and other like shade and shelter (Kahsay *et al*., 2001). In Dire Dawa Administration, farmers practice on farm and home garden for economic, social and environmental benefits (Getahun *et al.,* 2014). These traditional agroforestry practices could be intensified by using fast growing multipurpose tree species (MPTS) to satisfy the demands of the growing population. Thus, before introducing any species to a given agro ecology, there is always a need for a well conducted field trial for matching of the species/provenance to a particular site (Mebrate *et al*., 2004). Deciding what species to plant in any agroforestry system to meet the intended objectives require a well-conducted field trial to match a species to a particular site. Many species screening experiments have been conducted in different parts of country (Betre Alemu *et al.,* 2000). However, information is scarce at Dire Dawa Administration the promising multipurpose tree and shrubs species for use in agro forestry practices. Hence, there is a need to investigate adaptable and promising tree and shrubs species in the areas. Therefore, this trail was designed to evaluate the adaptation and growth performance evaluation of five agroforestry tree species to Dire Dawa Adada kebele conditions and sites of similar agro-ecology.

EXPERIMENTAL

Description of the study area: The experiment was conducted at Dire Dawa Administration; Biyyo Awalle cluster; Adada kebele which is located at 41^{0}51'E longitude, 9^{0}31'N latitude and an altitude of 1160 m a. s. l. It is situated in the semi-arid tropical belts of eastern Ethiopia at the middle of the eastern Hararghe mountain chain. The area experiences a bimodal type of rainfall with the mean annual precipitation of 556.5 mm. The mean annual maximum and minimum temperatures vary from 28.3^{0}C to 34.9^{0}C and 15.1^{0}C to 22.7^{0}C, respectively. Soil type of the experimental site is clay loam. The area is classified under semi-arid climate (Adnew, 2005).

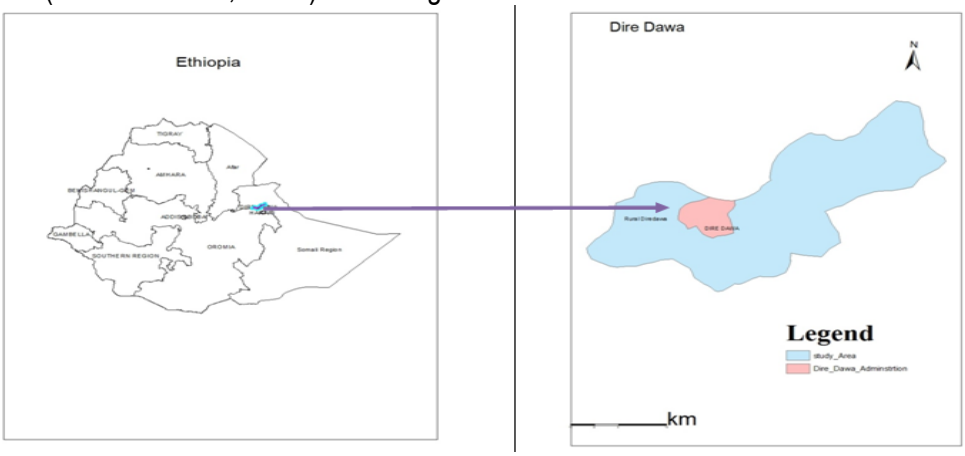

Figure 1. Study area location

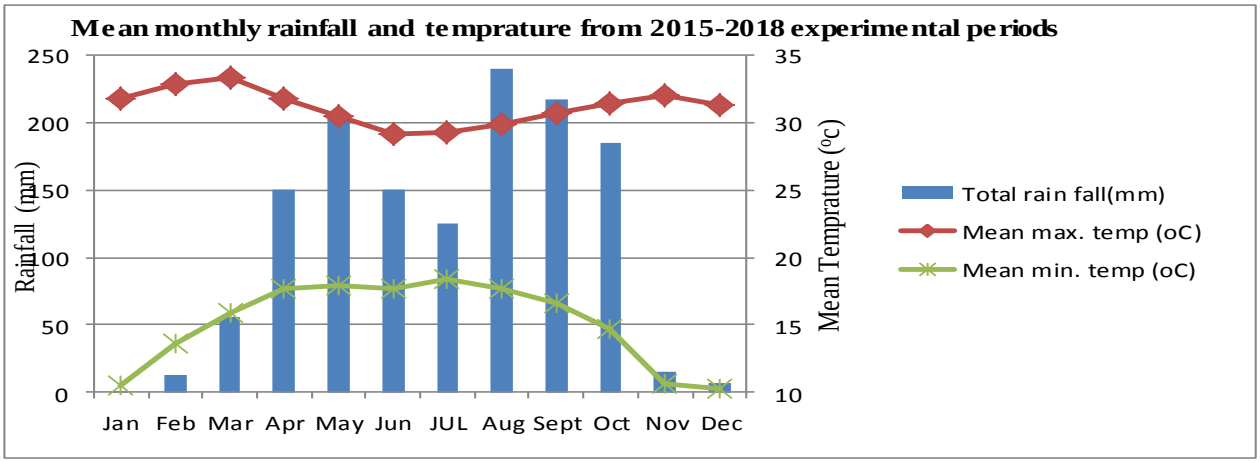

Figure 2. Rainfall and Temperature during 2015-2018

Treatments and Experimental design: Seed of the species (*Moringa stenopetala, Grevillea robusta*, *Sesbania sesban*, *Leuceana leucocephala* and *Azadarichta indica*) that used for the experiment were obtained from Central Ethiopian Environment and Forestry Research Center. Seedlings were raised directly into polythene tubes at Adada tree nursery with the recommendation of nursery activities. One to two

Data Collection: In order to fit the given objectives, data were collected on growth and adaptation parameters such as Plant height, root collar diameter, diameter at breast height and survival rate for the three years at interval of three months. Root collar diameter were collected only up to the tree reaches 1.3 meters in height and diameter at breast height were collected after tree reaches1.3 m whereas plant height and survival rate were up to the end of the period of the activity. Height growth was determined by using measuring tape and root

The analysis of variance of the survival rate recorded by the end of the experiment revealed that there were highly significant differences among the species ($p<0.05$). After three years of establishment, *Moringa oliefera*, *Azadarichta indica, Leuceana leucocephala* and *Sesbania sesban* were the species attained the highest mean values, while Gravilea *robusta* specie had the lowest value (Table 1). *Moringa olifera* demonstrate the highest survival rate at experimental site it may quite drought resistant

seed were put in polythene tubes and the weak one were removed out (transplanted to other polythene tubes) sometime after emergence. The experiment was arranged with Randomize Completely Block Designed (RCBD) in three replications. Seedlings were out planted on a plot of 12mx12m for each species. Spacing between rows and within row was based on recommendation of each species.

collar diameter and diameter at breast height by digital caliper.

Data Analysis: The data collected were analyzed using appropriate statistical package (SAS and Minitab) to test the significant difference among tree species. Least significant different (LSD) test was employed to separate statistically different means using the software package at 0.05 level of probability.

RESULTS AND DISCUSSION

Survival Rate

tree species. Yitebitu, 2004 also reported similar to the observation of the present study. This can be attributed to the moisture stress experienced, which as Kozlowski *et al.* (1991) also stated can affect the growth, survival and distribution of forest trees. *Azadarichta indica, Sesbania sesban, Leuceana leucocephala* demonstrated the good survival rate at Dire Dawa, Adada kebele. Hence, it can be inferred that the condition of Dire Dawa matched well with the environment requirement of these species, while

Gravilea robusta on the other hand, showed lowest survival rate at study area. The long dry season, which extended from seven to nine months in the study areas, clearly explains the low survival of the *Gravilea robusta* seedlings during the experimental period. In the present study, the mortality was subjectively attributable to abiotic factors such as drought and moisture stress during the initial growth from October to June, at study area. Thus, the environmental condition of Dire Dawa not suitable for *Gravilea robusta.* Soil and below ground competition are also other factors that influence the growth and survival rate (Casper and Jackson, 1997). Highly significant variations were among the tree species in survival rate ($p<0.05$) was recorded at all three years of age after transplanting.

Table 1. Mean survival rate (%) of agroforestry tree species planted in Biyyo Awalle; Adada kebele, over three years (2016/17- 2018/19)

Tree species	Status of Seedlings after Transplanting		
	Year 1	Year 2	Year 3
Moringa oliefera	95.00[a]	90.00[a]	85.00[a]
Azadarichta indica	89.00[a]	88.33[a]	83.33[a]
Leuceana leucocephala	89.67[a]	80.00[a]	76.67[a]
Sesbania sesban	86.67[a]	85.00[a]	76.67[a]
Gravilea robusta	65.00[b]	42.33[b]	37.00[b]
LSD (0.05)	9.86**	12.00**	12.67**
CV (%)	6.20	8.30	9.40

N.B. Means in columns with the same letters are not significantly difference using LSD
CV=Coefficient of Variation, LSD= Least Significant Difference

Height Growth

Analysis of variance revealed that variations in height among tree species were highly significant ($p<0.05$) after three years of age at study area. Height growth trend (Table 2) showed that *Azadarichta indica* and *Moringa oliefera* were the tallest trees, followed by *Sesbania sesban, Leuceana leucocephala* but *Gravilea robusta* showed the shortest tree. The growth performance showed that *Azadarichta indica* and *Moringa oliefera* were higher than the other species while *Sesbania sesban* and *Leuceana leucocephala* showed good growth performance at the study area. Similarly, Raebild *et al*., (2003). There was significant variation among tree species in diameter growth at the study area. Diameter growth trend (Table 2) showed that the highest root collar diameter was recorded for *Azadarichta indica* followed by *Moringa oliefera, Sesbania sesban* and *Leuceana leucocephala* but the lowest root collar diameter was recorded for *Gravilea robusta* at Dire Dawa environment condition. Growth in diameter at breast height also stated that apart from indicating productivity, height may also be seen as a measure of the adaptability of trees to the environment as tall trees usually being better adapted to the site than short trees(Cossalter,1987). Several similar studies also showed that fast growth of seedling is an important indicator in terms of determining the situation of growth response especially in the first growing period and it is commonly assumed that the early fast growth rates of tropical trees reflect productivity status of the trees (Baris and Ertenkin, 2010).

Diameter Growth

also highly significant ($p<0.05$) for the five agroforestry tree species at the study area. The difference in growth of diameter at breast height (1.3 m) above the ground of tree species *Azadarichta indica, Moringa oliefera, Sesbania sesban* and *Leuceana leucocephala* showed highest diameter at breast height(DBH) within three years data records at Dire Dawa Administration, Adada environmental condition.

On the other hand, *Gravilea robusta* showed the lowest diameter at breast height growth at the study area.

Table 2. The mean of Plant height, survival rate, diameter at breast height and root collar diameter of agroforestry tree species for three years (2016/17 – 2018/19) at Dire Dawa Administration; Adada kebele

Tree species	Survival rate (%)	Height (m)	RCD (cm)	DBH (cm)
A. indica	87.00^{a}	4.17^{a}	10.65^{a}	5.13^{a}
G. robusta	48.00^{b}	1.53^{d}	4.91^{c}	3.25^{b}
L. leucocephala	82.33^{a}	3.47^{bc}	8.07^{b}	4.47^{a}
M. oliefera	90.33^{a}	3.90^{ab}	9.93^{a}	4.58^{a}
S. sesban	83.00^{a}	3.38^{c}	7.75^{b}	4.87^{a}
LSD(0.05)	8.51	0.49	1.18	0.77
CV (%)	5.80	6.60	7.60	9.20

Means with the same letters are not significantly different using LSD, RCD =Root color diameter, DBH=Demeter at breast height, CV=Coefficient of Variation; LSD= Least Significant Difference

CONCLUSION

The experiment was conducted for three consecutive years (2016-2019) to evaluate adaptation and growth performance of five agroforestry tree species at Dire Dawa Administration Adada kebele. The result revealed that the survival rate of *Moringa oliefera* was the highest at the experimental sites followed by *Azadarichta indica*, *Sesbania sesban and Leuceana leucocephala.* While *Gravilea robusta* showed poor survival rate at the study area. Poor survival rate and growth performance might be attributed to the condition and termite problems of the study area. *Moringa oliefera*, *Sesbania sesban, Leuceana leucocephala and Azadarichta indica* were the species attained the highest mean heights, while *Gravilea robusta* had the lowest values at. The comparisons between the height and diameter growth average of the species showed that *Azadarichta indica* had the highest mean height followed by *Moringa oliefera, L*euceana leucocephala and *Sesbania sesban* at study areas condition. Generally, results on growth performance showed that *Azadarichta indica, Sesbania sesban*, *Moringa oliefera and Leuceana leucocephala* had better performance than *Gravilea robusta*. Accordingly, those tree species which had better performance were recommended for further demonstration and evaluation in the study area and similar agro ecologies. Therefore; planting of these better performing tree species and increase their promotion as agroforestry practices were recommended for soil conservation, shading, forage, and fuel wood in the area. On farm evaluation of *Sesbania sesban, Leuceana leucocephala* and *Moringa oliefera*, and their contribution to soil fertility improvement and crop yield either in inter- cropping or biomass transfer has to be further investigated to make use of their potential in agro forestry practices.

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