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RESEARCH ARTICLE

GROWTH PERFORMANCE EVALUATION OF MULTIPURPOSE TREE AND SHRUB SPECIES FOR PROMOTION OF AGROFORESTRY PRACTICE AT BORE DISTRICT, GUJI ZONE, SOUTHERN ETHIOPIA

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ABSTRACT

This study was conducted at Bore Agricultural Research Center, on station. The objective of this study was to identify the best adaptable agro forestry multipurpose tree and shrub species for the study area. Seedlings of multipurpose tree and shrub species were out planted in a randomized complete block design (RCBD) with three replications. A plot size of 13mx7m was used for each multipurpose tree and shrub species selected for this study. A plot consisted of three rows of multipurpose trees, on each row three multipurpose trees were planted and each plots had nine multipurpose trees. Based on the objective of this study, quarterly the following parameters such as survival rate, tree height and diameter at breast height (DBH) were recorded until the end of the study. The results of this study revealed that, multipurpose tree and *shrub species* such as *Acacia abysinica, Grevillia robusta, Hagenia abysinica, Acacia saligna* and *Pinus patula* had the highest survival rate at the study site. In addition, their survival rate were significantly (P<0.05) higher than *Cordia africana, Susbania acculeta* and *Leuceana leococephala* multipurpose tree species. However, from all multipurpose tree and shrub species selected for this study *Leuceana Leococephala* was shown poor survival rate. The reason low survival of *Leucaena leucocephala* was observed at study site was due to agroecology of the study site was not suitable for the species. The height data recorded by the end of the experiment revealed that there were not significance (P<0.05) differences in height were viewed between *Acacia saligna, Acacia abysinica,Grevillia robusta* and *Hagenia abysinica* multipurpose tree and shrub species and all the tree species were attained the highest mean value respectively. However, *Cordia africana, Susbania acculeta* and *Leucaena leucocephala* were multipurpose tree and shrub species achieved the lowest mean value respectively.Diameter at breast height (DBH) data recorded at the end of this study showed that, *Acacia abysinica* and *Acacia saligna* were the tree species attained the highest mean values of DBH and *Grevillea robusta, Pinus patula, Hagenia abysinica* and *Susbania acculeta* attained medium mean values of DBH. However, from multipurpose tree and shrub species selected for this study, *Cordia africana* and *Leuceana Leococephala* had the lowest value of DBH. Generally, these findings could be used to promote those adapted promising native and exotic multipurpose tree and shrub species for promotion of agroforestry practice. Moreover, it can help all stake holders to properly allocate species into the site that grow and adapt well.

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INTRODUCTION

Agro forestry is a sustainable land management practice that incorporates trees and shrubs in crop lands and pastures. The trees help to moderate air temperature, serve as wind breaks and improve water infiltration by reducing evapo-transpiration by the extent proportional to tree height.

In addition vegetation produces wood, fruits, fodder and medicine which diversify livelihood sources for the rural poor (Bashir *et al.,* 2006). The major role of agro forestry, to maintain soil fertility, is based primarily on observation of higher crop yields in association with multipurpose tree species. Multipurpose tree species play a crucial role in sustenance of soil productivity through litter production, regular supply of viable nitrogen over a longer period by nitrogen fixation, fine roots turn over and nutrient cycling and

improvement in soil structure (Solanki, *et al.,* 2008). Diversification of agro forestry practice contributes to biodiversity conservation through reducing pressure on natural forests and protected conservation areas. Agro forestry systems that are structurally complex and floristically diverse can contribute significantly to the conservation of biodiversity within fragmented landscapes (Ashley *et al.,* 2006). The integration of woody species in agricultural landscape could reduce the pressure on the surrounding natural forest. For instance, agroforestry, which combine forestry and agriculture, have the capacity to sustain the productivity of farmlands. Moreover, diversification of agroforestry system could also serve as buffer zone for forest degradation and deforestation (Nair, 1993). Multipurpose tree and shrubs species play a considerable role in addressing such multifaceted demands in the mixed crop-livestock production system (Alemu 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 (Berhe *et al*., 2001). In Ethiopia, efforts have been made to develop and promote different agro forestry technologies. However, technologies developed and promote so far are not sufficient to address the problems of soil erosion, loss of soil fertility, loss of bio diversity, shortage of fodder and woody material scarcity for industrial and house hold consumption(Zebene and Agren, 2007). Many research findings indicated that, the major problems in promoting agro forestry are lack of improper selection of tree species, non availability of good planting material and in adequate supply of multipurpose germplasm were among the factors that constrained agro forestry development. Similarly, in high land Districts of Guji Zone, Southern Ethiopia diversification of agro-forestry technology is constrained by lack of awareness about the benefits of agro forestry practice and non availability of good quality planting material of multipurpose tree and shrub species. Presently, existing traditional agro forestry in high land districts of Guji zone is very limited and natural forest of the area is disappearing at alarming rate due to expansion of agricultural lands, for fuel wood consumption and timber producing firms, a wide range of both material and intangible benefits of trees decrease from time to time. The disappearance of the resource at an alarming rate resulted in a number of consequences such as soil erosion, loss of soil fertility and shortage of woody material scarcity. Therefore, designing strategies to address the problem through planting of agro-forestry multipurpose tree and shrub species used to solve the crisis is very crutial. This can be achieved by adaptation of suitable multipurpose tree and shrub species and through motivating farmers to plant different types of multipurpose tree and shrub species appropriate to their agro-ecology. So far, available information on the performance of multipurpose agroforestry tree and shrub species in high land Districts of Guji zone is very limited. Thus, introduction and improved management of adaptable multipurpose agroforestry tree and shrub species can be one of the strategies to minimize the current wood, feed and soil related constraints of the study area. Therefore, this study was conducted to identify the best productive and adaptable agro forestry multipurpose tree and shrub species for high land Districts of Guji Zone.

MATERIAL AND METHODS

Description of the study area: The experiment was conducted at Bore Agricultural Research Center on station for four years. The experimental site is about 385 km far from Addis Ababa. Geographically, the experimental site is situated at altitude of $06^{0}23^{1}55''N$ and longitu$38^{0}35^{1}5''E$.The experimental site represented high land agro-ecologies of Guji Zone having an altitude range of 2200-2780M above sea level. The area receives an annual rain fall ranging from1400-1800mm with a bimodal pattern that is extended from April to November. The mean annual minimum and maximum temperature of the experimental site is $10^{o}C$ and $20^{o}C$ respectively. The soil type of the experimental site is red basaltic soil (Nitosols). The soil is clay loam in texture and strongly acidic with pH 4.53 to 5.13 while moderately acidic with pH 6.5.

Multipurpose Tree and Shrub Species Seed Sources and Nursery Management: As indicated in Table 1 below, seeds of three indigenous and five exotic multipurpose trees and shrub species included in the trials were obtained from Central Ethiopia Enviroment and Forestry Research Center, Addis Ababa. Seedlings of the multipurpose tree species were raised at nursery site established at Bore Agricultural Research Center, on-station. During the seedlings for the trials were raised at nursery site universal soil ratio of 3, 2, 1 (local soil, forest soil and sandy soil) was used so that seedlings have a ball of earth around their root system. This is intended to ensure high survival rate of seedlings when planted out in the field. Seed of multipurpose tree species was done on seedbeds and after germination the seedlings were pricked out in a pot size of 8cm-12 cm and pot height of 10 cm based on type of multipurpose tree and shrub species selected for the trials. Optimum care, such as watering, mulching, shading and weeding were provided at the nursery site to produce healthy and vigorous seedlings for field planting.

Experimental Design and assessment of the treatments: After all the multipurpose tree and shrub species seedlings were ready for field planting, they were planted at Bore Agricultural Research Center, on-station in a randomized complete block design (RCBD) with three replications. Seedlings were out planted at the study site on a plot size of 13mx7m for each multipurpose tree species. A plot consisted of three rows of multipurpose trees. On each row three multipurpose trees was planted and each plots had nine multipurpose trees. Distance between the trees in the same row was 4m and distance between rows in the same plot was 3m. Based on the objective of the study, quarterly for four years the following parameters such as survival rate, tree height and diameter at breast height (DBH) were collected. Multipurpose tree and shrub species heights were measured using either meter tape or graduated stick depending on the height of the multipurpose tree and shrub species being assessed. Diameter at breast height (DBH) of the planted multipurpose tree species were assessed at the base of the seedlings or saplings using caliper. Survival assessment of the planted multipurpose tree and shrub species was carried out based on the original number of trees planted.

Data Analysis: The analysis was performed by using Statistical Analysis System (SAS version 9). Survival rate, tree height and diameter at breast height data recorded from each selected multipurpose tree species were subjected to analysis of variance and Least Significance Differences (LSD) tests to enable comparison of multipurpose tree and shrub species.

RESULTS AND DISCUSSION

Survival Rate of the Multipurpose Tree and Shrub Species: Survival rate of the multipurpose tree and shrub species selected for this study revealed that, statistically there were not significance (P<0.05) differences observed in survival rate between *Acacia abysinica*, *Acacia saligna*, *Grevillia robusta*, *Pinus patula* and *Hagenia abysinica* (Table 2). The lack of significant differences in survival rates among the five multipurpose tree and shrub species in the same category showed that their level of survival rate in the study area is more or less the same. However, in terms of their survival % from all multipurpose tree and shrub species selected for this study *Accaia abysinica* and *Grevillia robusta* were totally (100%) survived. This indicated that the climatic condition of the study area was suitable for growing those multipurpose trees pecies. Relatively similar to this study finding, the study result conducted in Gimbo District, South western Ethiopia and at Haro-Sabu, Kellem Wollega Zone showed that *Grevillia robusta* have survival rate of 80.6% and 81.81% respectively (Fikadu *et. al,2017*;Getahun *et. al,2017).*

Recorded Survival data of *Hagenia abysinica*, *Acacia saligna* and *Pinus patula* indicated that their survival % was 94%, 89% and 72% respectively. Hence, it can be inferred that the condition of the study area matched well with environment requirement of these multipurpose tree and shrub species. Based on the finding of this study, there were not significance (P<0.05) difference in survival rate between *Cordia africana* and *Suspania susban* multipurpose tree and shrub species. However, there was significance (P<0.05) differences in survival rate between *Leucaena leucocephala* and the remaining multipurpose tree species used on this study. Because, from all multipurpose tree species selected for this study *Leucaena leucocephala* was totally (100%) not survived. The reason low survival of *Leucaena leucocephala* was observed at study site was due to it grows best in humid tropical and Moist and Wet lowland agroclimatic zones in full sunlight on well-drained neutral or calcareous soils, 0-1,600 m(Azene Bekele,2007). However, in contrast to this study result, under moisture Stressed environment of Northern Ethiopia due to the long dry season survival rate of *L. leucocepala* had showed a marked decrease from 77.8% to 25.9% in the specified period compared to the other species (Abraham and Kidane, 2014).

Table 1. List of Indigenous and Exotic Multipurpose Tree and Shrub Species selected for the study

Multipurpose Tree and Shrub Species Scientific name	Multipurpose tree and Shrub species family name	Multipurpose Tree and Shrub Species Common name
Cordia africana (Lam.)	*Boraginaceae*	Broad leave Cordiana
Acacia abyssinica (Hochst.)Benth	*Mimosoideae*	Flat-top acacia
Hagenia abysinica	*Rocaceae*	African redwood
Accacia Saligna.	*Fabaceae*	Weeping wattle
Sesbania sesban (L.) Merr.	*Papilionoideae*	African tulip tree
Grevillea robusta (R. Br.)	*Proteaceae*	Silky oak
Pinus patula	*Pinaceae*	Mexican weeping pine
Leucaena leucocephala	*Fabaceae*	White lead tree

Table 2. Mean survival of Acacia abysinica, Acacia saligna, Grevillea robusta, Pinus Patula, Hagenia abysinica, Cordia africana, Leuceana Leococephala and Susbania susban multipurpose tree and shrub species

Multipurpose Tree and Shrub Species	Mean Survival rate of Multipurpose Tree and Shrub species
Acacia abysinica (Hochst.) Benth	100[a]
Acacia saligna	83.3[a]
Grevilia robusta (R.Br.)	100[a]
Pinus patula	77.77[a]
Hagenia abysinica	94.43[a]
Cordia Africana (Lam)	44.43[b]
Leuceana Leococephala	0[c]
Susbania susban (L.) Merr	40.12[b]
Mean	20.5
LSD (0.05)	24.99
Cv (%)	22.8

**Means in columns with the same letters are not significantly different at (P<0.05)*

**Means in columns with the different letters are significantly different at (P<0.05)*

Table 3.Mean height and mean diameter at breast height (DBH) for Acacia abysinica, Acacia saligna, Grevillea robusta, Pinus Patula, Hagenia abysinica, Cordia africana, and Leuceana leococephala and Susbania susban

Multipurpose Tree and Shrub Species	Mean Height and DBH of Multipurpose Tree and Shrub Species	
	Height (cm)	DBH (cm)
Acacia abysinica (Hochst.) Benth	438.7[a]	8.333[a]
Acacia saligna	441.9[a]	7.663[a]
Gravilia robusta (R.Br.)	417.8[a]	6.220[ab]
Pinus patula	317.9[b]	5.417[b]
Hagenia abysinica	407.7[a]	5.033[b]
Cordia africana (Lam)	190.4[c]	1.143[c]
Leuceana Leococephala	0[c]	0.000[c]
Susbania susban (L.) Merr	184.2[c]	5.172[b]
Mean	241.8	2.23
LSD (0.05)	78.69	1035
Cv (%)	17.2	27.5

**Means in columns with the same letters are not significantly different at (P<0.05)*

**Means in columns with the different letters are significantly different at (P<0.05)*

Height Growth of the Multipurpose Tree and Shrub Species: As the findings of this study indicated that, the combined analysis of the four years height of the multipurpose tree and shrub species seedlings transplanted at the study site showed that, there were not significance ($P<0.05$) differences in height were viewed between *Acacia saligna, Acacia abysinica,Grevillia robusta* and *Hagenia abysinica* multipurpose tree species (Table 3).The recorded mean height of *Acacia saligna, Acacia abysinica, Grevillia robusta* and *Hagenia abysinica* multipurpose tree species were: 4.4m, 4.3m, 4.2m and 4.1m respectively and as compared to others tree species used on this study height growth of these tree species are superior. Similarly, Cossalter C, 1987 and Raebild *et al.,* 2003 on their study results 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. The recorded mean heights of *Cordia africana* and *Susbania susban* were: 1.9m and 1.84m respectively (Table 3). As compared to others, height growths of the two multipurpose tree species are very slow. The poor height growth response observed on two multipurpose tree species that might be as a response to ecology and biophysical limits such as altitude, rainfall and soil type of the study area. Because, *Cordia africana* grows well in Dry, Moist and Wet midland agroclimatic zones and *Susbania susban* performs well in Moist and Wet lowland and mid land agroclimatic zones (Casper and Jackson, 1997; Azene Bekele, 2007).

Diameter Growth of the Multipurpose Tree and Shrub Species: The analysis of variance of the mean diameter at breast height (DBH) data recorded by the end of the experiment revealed that there were not significance ($P<0.05$) differences observed between *Acacia abysinica* and *Acacia saligna* multipurpose tree and shrub species. As well, as indicated in Table 3, there were not significance differences ($p<0.05$) of mean diameter at breast height (DBH) revealed between *Grevillea robusta, Pinus patula, Hagenia abysinica* and *susbania susban*tree species. As the combined analysis of the four year DBH data recorded indicated that, *Acacia abysinica* and *Accacia saligna* were the species attained the highest mean values of DBH and *Grevillea robusta, Pinus patula, Hagenia abysinica* and *susbania susban* attained medium mean values of DBH. While, *Cordia africana* multipurpose tree had the lowest value of DBH from the rest of multipurpose tree species used for the study (Table 3).

CONCLUSION AND RECOMMENDATION

Among multipurpose tree and shrub species selected and tested in this study *Acacia abysinica, Grevillia robusta, Hagenia abysinica, Acacia saligna* and *Pinus patula* are the most survived and promising tree species. However, survival rate of *Cordia africana* and *Susbania susban* multipurpose tree species were intermediate and *Leuceana Leococephala* was shown poor survival rate. The reason low survival of *Leucaena leucocephala* was observed at study site was due to it grows best in humid tropical and Moist and Wet lowland agro climatic zones in full sunlight. The height data recorded by the end of the experiment revealed that *Acacia saligna, Acacia abysinica, Grevillia robusta* and *Hagenia abysinica* multipurposetree species were attained the highest height growth respectively. However, as the finding of this study indicated that *Cordia africana, Susbania susban* and *Leucaena leucocephala* were multipurpose tree species achievedthe lowest height growth in that order.

In terms of diameter at breast height (DBH) data recorded at the end of this study showed that, *Acacia abysinica* and *Accasia saligna* were the species attained the highest mean values of DBH and *Grevillea robusta, Pinus patula, Hagenia abysinica* and *Susbania susban* attained medium mean values of DBH. However, from multipurpose tree species selected for this study, *Cordia africana* and *Leuceana Leococephala* had the lowest value of DBH. Generally, from the multipurpose tree and shrub species their growth performance were conducted at Bore Agricultural Research Center on station, *Acacia abysinica, Grevillia robusta, Hagenia abysinica, Acacia saligna* and *Pinus patula* were showed good performance. Therefore, planting and promotion of those good performed multipurpose tree and shrub species help farmers to get woody and non-woody forest products from their land and reduce the pressure on the natural forest of the area. Generally, this finding could be used to promote those adapted promising native and exotic multipurpose tree and shrub species for promotion of agroforestry practice. Moreover, it can help all stake holders to properly allocate species in to the site that grow and adapt well.

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REFERENCES

Abriham Mahari and Kidane Giday, 2014. Initial growth response of five multipurpose tree species under moisture stressed environment, Northern Ethiopia: Implications for rehabilitation of degraded areas in the dry lands. Merit Research Journal of Agricultural Science and Soil Sciences, Vol. 28 pp. 104-110,

Alemu B, Mamo T, Zewdie A, Ahmed E 2000. Promising multipurpose tree species and their response to land form on highland vertisols at Chefe Donsa, central highland of Ethiopia. pp. 145-155.

Azene Bekele-Tesema2007.useful trees and shrubs for Ethiopia. SIDA'S Regional Soil

Conservation unit. Nairobi,Kenya.

Berhe K, Conchedda G, Jabbar M 2001 Areas suitable for five leguminous trees and shrubs in Ethiopia: A digital data based analysis. Ethiopian Journal of Natural ResourcesEJNR31:77-97

Casper B, Jackson RB 1997. Plant competition underground, Annu. Rev. Ecol. Syst. 28: 545-570. Conservation unit. Nairobi, Kenya.

Cossalter C 1987 Introduction of Australian acacias into dry, tropical West Africa. Forest Ecology and Management 161-4: 367-389.

Fikadu Kitaba, Tamam Mama and Wegene Negese2017. Adaptation and Growth Performance of Multipurpose TreesUnder Haro Sebu Condition. Journal of Biology, Agriculture and Healthcare, Vol.7, No.23, 2017

Nair N. K. R. 1993. An introduction to agroforestry. Kluwer Academic Publisher, Dordrecht, The Netherlands, 1993. pp. 499

Raebild A, Graudal L, Rehman SK 2003 Evaluation of a provenance trial with *Acacia albida, A. Senegal and A. tortilis* at Dagar Kotli, Pakistan. Trial no. 21 in the arid zone series. Results and Documentation No. 26.

Solanki, Bisaria and Handa2008 Multipurpose Tree Species: Research, Retrospect and Prospect, India

Yazachew E, Kasahun D 2011.The National regional government of Oromia, Physical and Socio economic profile of Guji zone Districts. Bureau of Finance and Economic

Development. The National Regional Government of Oromia, Addis Abeba

Zebene, A. and Agren.G. 2007. Farmers' local knowledge and top soil properties of agroforestry Practices in Sidama, southern Ethiopia. *Journal of Agroforest system*, Vol.71:35-48

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