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Initial Growth Responses of Multipurpose Tree Species Under Termite Infested Areas at Mana Sibu District of West Wollega Zone, Oromia Regional State, Ethiopia

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Abstract: An experimental study was carried out at Mana Sibu district of West Wollega zone, Oromia Regional state, Ethiopia to evaluate and select multipurpose tree species for rehabilitation of termite degraded area. Seven tree species (*Cordia africana, Melia azedrach, Albizia gummifera, Jacaranda mimosifolia, Acacia mearnsii, Acacia albida* and *Croton macrostychus*) were used for the experiment and both organic and inorganic fertilizers were also used as a treatment to support the seedlings for initial survival. The treatments were arranged in the split plot using RCB Design with three replications in which the fertilizers were randomized on main plots and tree species on sub plots of the main plot. Data on dead seedlings count of the planted trees, Root collar diameter and height of the tree species were collected. SPSS statistical computer software was used to analyze the data. The result of the analysis revealed that there was significance difference between the survival counts of tree species with respect to termite attack. Hence, *Cordia africana* and *Acacia mearnsii* were the most susceptible ($p<0.05$) tree species to termite attack followed by *Albizia gummifera* and *Croton macrostychus*, whereas *Jacaranda mimosifolia* and *Melia azedarach* were tolerant as compared to the others. There was no significance difference between the applications of the different fertilizers to support the seedlings for initial growth and survival but there was numerical difference such that application of inorganic fertilizer had more survival followed by organic fertilizer application. However, plots with no fertilizer application (control) showed less survival than both fertilizers. In general *Jacaranda mimosifolia* and *Melia azedarach* were very tolerant to termite attack followed by *Albizia gummifera* when compared to *Cordia africana* and *Acacia mearnsii* which were very susceptible. However, application of any fertilizer type for supporting the initial survival of the seedlings was not important from an economic point of view since there was no statistically significance difference with the control. Therefore, selection of appropriate tree species which tolerate termite attack without the application of any fertilizer for rehabilitation of termite degraded areas was very crucial.

Keywords: Multipurpose Tree, Root Collar Diameter, Organic Fertilizer, Inorganic Fertilizer, Rehabilitation, Termite

1. Introduction

Geographically, termites are mainly tropical and subtropical insects whose distribution extends up to 450N and 500S [1, 2]. Ethiopia is among the countries known for their termite fauna in tropical Africa. The Ethiopian zoogeographical region in general, is the richest in termite fauna and has been center of origin for many species [3]. Termites are serious pests in tropical and subtropical Africa. They attack various field and plantation crops. Termites damage pasturelands, which are primarily used for livestock production. Ethiopia is among the tropical countries where crops and pasturelands are severely damaged by these pests. Increasing reports [4, 5, 6] indicated that the problem is more sever in western Ethiopia.

In Ethiopia there are 61 species of termites in 25 genera and four families, of which very few are regarded as pests [4]. According to references [7, 8], in the last 40-50 years,

the damage caused by termites in western Ethiopia became more and more acute. West Wollega zone has been known to suffer from increasing termite problems for the last 20 years, and now spreading rapidly in easterly direction from the affected districts of the west [6]. These reports underlined that the problem has become so complex that the farmers around Mendi, the capital town of Mana Sibu district in western Ethiopia, have been forced to abandon their lands and move to less affected lowland areas. Cowie and Wood [9] reported that termite in western Ethiopia has damaged up to 6% of grass was covered by termite soil sheeting and an average of 15 foraging holes per meter square were observed in rangelands.

Abdurahiman [4] noted, by citing Mana Sibu district Administrator (personal communication), that the first termite damage report came in 1938 from around Kiltu Kara, a small town in Mana Sibu district, western Ethiopia. The magnitude of the problem was not similar throughout west Wollega; it appears that Mana Sibu, Nedjo Jarso, Ayra Gullisso and Gimbi were the most seriously affected districts [4]. Owing to their feeding behavior, termites are injurious to miscellaneous field and plantation crops, forestry, and rangelands as well as wooden materials. Different reports showed that termites cause serious damages to plantation crops such as cacao, coconut, coffee, oil palm, rubber tree, sugarcane and tea; to field crops such as groundnut, cotton, rice, wheat, maize; to rangelands and trees [1, 10]. By cutting young seedlings or hollowing out matured stems of living trees, in many tropical and subtropical countries, termites cause economic loss to commercially important timber species [11, 12].

The causative agents for land degradation are both biotic and abiotic, of which destruction of natural vegetation mainly forest by natural as well as manmade is the major and the number one problem in most developing countries like Ethiopia. As the land is degraded the biological composition will decrease and hence, reduction in economic growth, change in micro and macro climate, loss of valuable species, which in turn leads to the occurrence of wood and food insecurity become the periodical problem in the country.

Forest fire is one of the major causes of deforestation. Tropical forests have not only shrunk in area due mainly to encroaching agriculture, but vast areas have also been severely degraded by exploitation and by forest fires. Also, in February 2000, the damaged area by fire hazard in Bale, Borana, Jimma and Wollega zones of Oromiya Region is estimated at being more than 150,000 hectares of high forests [13]. This consequent deforestation by fire is also one of the major contributors to land degradation.

Termite is also another causative agent for land degradation through destruction of the existing vegetation. It is the problem found in most parts of the country. Termite are abundant and widely distributed throughout the regions of Ethiopia but pose a threat to crops, forestry trees, rangeland and domestic houses especially in western Wollega zone [14].

The present study aims to assess the growth performance of tree species in terms of early growth characteristics such as survival, height and root collar diameter to identify and recommended the best-performing ones in most adaptable to the degraded lands and for rehabilitation of termite degraded areas Western Wollega, Oromia Ethiopia.

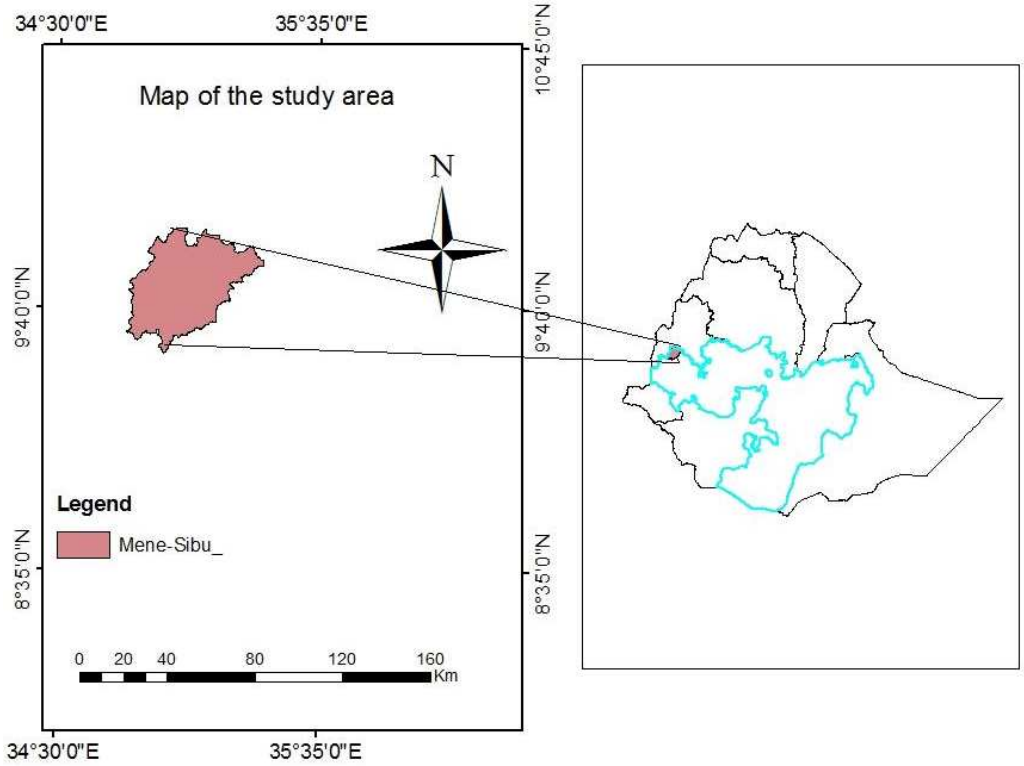

Figure 1. *Map of the Study Area.*

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Mana Sibu district of West Wollega zone of Oromiya Regional State, Western Ethiopia located at 580km west of the capital Addis Ababa. According to the Mana sibu District Agricultural Development office, agro-climatically, the study area lies within two agro-ecological zones (AEZ): Woyina Dega (mid altitude) and Kola (Lowland), which constitutes for 68% and 32% of the total area, respectively. The annual temperature of the district varies from 24°C to 29°C with annual average temperature of about 26°C and the annual rainfall ranging from 900-1800 millimeters. The district gets mean annual rainfall of about 950 mm. The rainy season usually starts in April and extends up to October, with the highest rainfall concentration between June and August. The dry season is from November to March. In general, Mana Sibu district has favorable weather conditions for various agricultural productions both in the mid altitude and lowlands [15].

2.2. Experimental Design, Data Collection and Analysis

Seven multipurpose tree species were selected by making group discussion with the local people, Mana Sibu Environmental Rehabilitation Project (MERP) district bureau of natural resources and seedlings of the species were raised in nearby nursery. When the seedlings reached plantable size, they were transplanted to the field with the proposed experimental design.

There were two types of treatments used. The first was multipurpose tree species for screening the best species adaptable to the area under severe degradation (randomized on sub-plots) and the second was two types of fertilizer (inorganic, organic fertilizer) and the control. In this case, control plot was a plot with no fertilizer application but planted with the selected tree species. Split plot using Randomized Complete Block Design (RCBD) were used with three replications in which spot application of fertilizers were used on main plots and tree species on sub-plot. Data on dead seedling count, root collar diameter and height of the species were collected.

Data on dead seedlings with respect to termite attack and fertilizer types were analyzed by SPSS computer software of version 16. One way analysis of variance (ANOVA) was performed to determine the tolerant ability of the seedlings to termite attack based on survival count and the effect of fertilizer application on the survival of the seedlings, and the mean comparison were made using the Tukey Honest Significant Difference (HSD) test at 0.05 significant levels.

3. Result and Discussion

3.1. Survival, Root Collar Diameter (RCD) and Height of Tree Species

3.1.1. Survivals

The analysis variance of survival data, in the interaction of tree species with different level fertilizer revealed that there were non-significant ($P>0.05$). Survival two years after planting ranged from 0%–36.44%, the lowest survival was for the *Acacia mearnsii* and *Cordia africana*, the highest for *Melia azedrach* and *Jacaranda mimmosifolia* (Table 1). High variability in survival was observed between tree species *Cordia africana*, *Acacia mearnsii* and *Melia azedrach* tree species. Survival varied significantly ($P<0.001$) between different tree species (Table 1).

Survival data of the seven species under the present investigation revealed that *Melia azedrach* was higher (36.44%) followed by *Jacaranda mimmosifolia* (22.6%), *Acacia albida* (19.11%), and the lowest survival *Albizia gummifera* (2.22%) and *Cordia africana* and *Acacia mearnsii* were total devastated species the survival rate of both species (0%) at the age 21 months and 17 month respectively. (Figure 2).

Table 1. *Mean values of survival percentage seedlings collected at different time.*

Tree species	Different time after planting to collected survival rate										
	3days	6days	9 days	12 days	45 days	5 month	9 month	12 month	17 month	21month	24 month
1 *Cordia africana*	84.89c	76.00d	68.00a	64.89d	43.11c	14.67c	5.33c	3.56c	1.33c	0.00c	0.00c
2 *Melia azedrach*	94.22ab	86.67abcd	81.78bc	78.67bcd	69.78ab	67.11a	58.67a	57.78a	55.56a	40.00a	36.44a
3 *Albizia gummifera*	98.67a	95.55ab	93.33ab	92.44ab	81.33a	68.00a	41.33ab	36.89ab	30.22b	22.67ab	2.22c
4 *Jacaranda mimmosifolia*	92.89ab	85.33bcd	81.33bc	74.22cd	57.78bc	44.89b	35.56b	30.67b	29.78b	26.22ab	22.67ab
5 *Acacia mearnsii*	89.78bc	83.56cd	78.22cd	70.22d	43.56c	2.22c	0.89c	0.44c	0.00c	0.00c	0.00c
6 *Acacia albida*	96.89ab	92.44abc	90.22abc	89.78abc	81.33a	75.11a	40.89ab	40.00ab	35.11ab	19.56bc	19.11b
7 *Croton macrostychus*	99.11a	97.78a	96.44a	94.67a	88.44a	73.78a	42.67ab	27.56b	24.89b	20.44ab	14.22bc

*Mean values followed by the same letters within each column are not significantly different at $P<0.05$ level according to Tukey Honest Significant Difference (HSD) test.

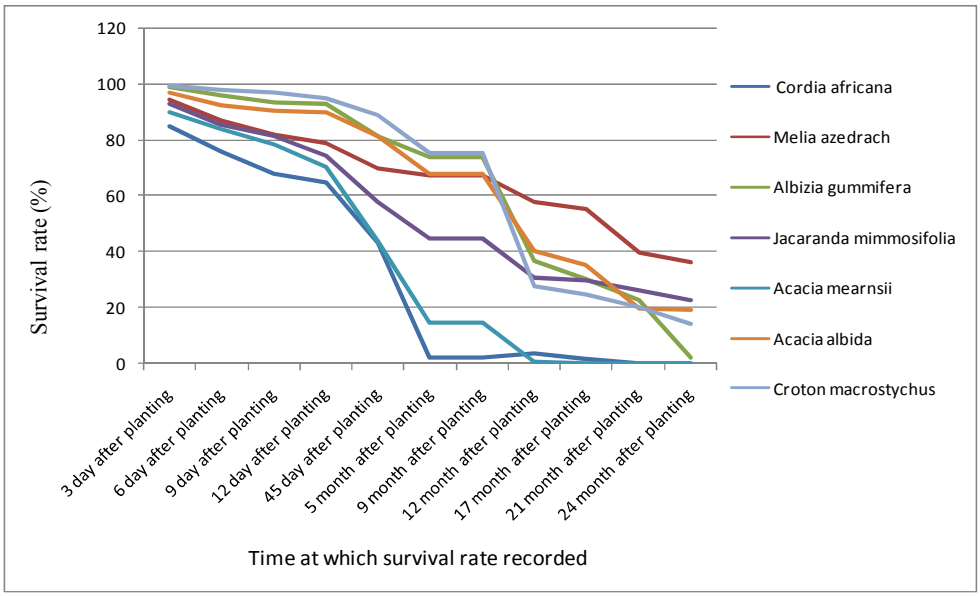

Figure 1. *Survival (%) trends of those planted species.*

3.1.2. Height and Root Collar Diameter (RCD) of Tree Species

The analysis of variance of the height data recorded by the age of 12 months after planting of the experiment revealed that there were highly significant differences among the species ($p<0.001$). *Acacia mearnsii, Jacaranda mimmosifolia* and *Melia azedrach* were the species attained the highest mean values, while *Albizia gummifera* and *Cordia africana* species had the lowest value (Table 2). In contrast the analysis of variance of the height data recorded by end of the experiment *Jacaranda mimmosifolia* and *Acacia albida* species attend the highestmean but *Acacia mearnsii* and *Cordia africana* total dead. (Table 2)

Similarly, the root collar diameter data also reviled that there were highly significant ($p<0.001$) differences among the species. High mean value of root collar diameter was recorded in *Jacaranda mimmosifolia* (1.2989 cm), while it was low in *Acacia albida* and *Albizia gummifera* species (0.3833 cm and 0.5633 cm respectively). (Table 3)

Table 2. *Mean Height of different tree species at different time data recorded.*

Tree species	Height (m) Months after planting					
	at 5 month	at 9 month	at 12 month	at 17 month	at 21 month	at 24month
1 *Cordia africana*	23.04d	31.92b	19.88de	26.36cd	*	*
2 *Melia azedrach*	34.75ab	33.12b	30.92bc	26.44cd	30.40 bc	38.79b
3 *Albizia gummifera*	16.01e	16.26c	15.87e	14.51d	16.85c	35.94b
4 *Jacaranda mimmosifolia*	21.82d	30.74b	37.27b	50.56b	71.88a	97.30a
5 *Acacia mearnsii*	37.95a	46.09a	56.49a	*	*	*
6 *Acacia albida*	28.26c	29.07b	21.57cde	28.48cd	35.60bc	54.83b
7 *Croton macrostychus*	33.50b	32.51b	29.51bcd	35.84bc	35.52bc	47.89b

*: no data available because the tree species total dead by termite i.e. 0% survival

Mean values followed by the same letters within each column are not significantly different at $P<0.05$ level according to Tukey Honest Significant Difference (HSD) test.

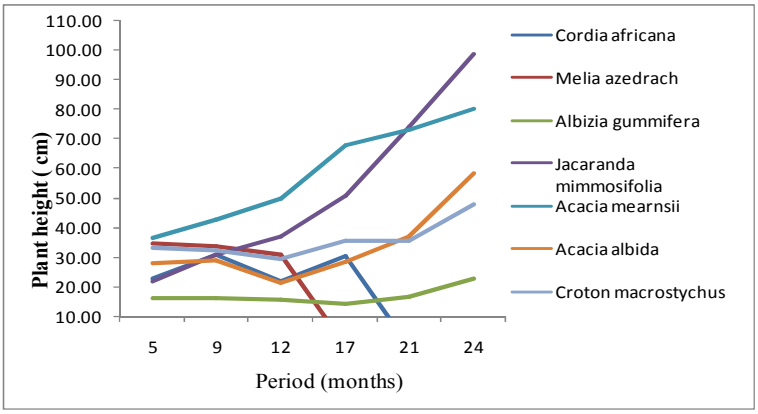

Figure 2. *Growth Mean Height at different time data recorded.*

Table 3. *Mean Root Collar diameter (RCD) of different tree species at different time data recorded.*

Tree species	RCD (cm)Months after planting					
	at 5 month	at 9 month	at 12 month	at 17 month	at 21 month	at 24month
1 *Cordia africana*	0.5889b	0.9509a	0.9808b	0.6625bc	*	*
2 *Melia azedrach*	0.5900b	0.7622bc	0.9411b	0.7033bc	1.189bc	0.744b
3 *Albizia gummifera*	0.4700c	0.5711d	0.5633de	0.5622bc	0.776de	1.215ab
4 *Jacaranda mimmosifolia*	0.7344a	0.8633ab	1.2989a	1.4789a	1.733aa	2.038a
5 *Acacia mearnsii*	0.4203c	0.6604cd	0.8125bc	1.5085a	1.359b	1.125b
6 *Acacia albida*	0.2456d	0.3344e	0.3833e	*	*	*
7 *Croton macrostychus*	0.5861b	0.7233c	0.6967cd	0.8444b	1.110bcd	1.093b

*: no data available because the tree species total dead by termite i.e. 0% survival
Mean values followed by the same letters within each column are not significantly different at P<0.05 level according to Tukey Honest Significant Difference (HSD) test.

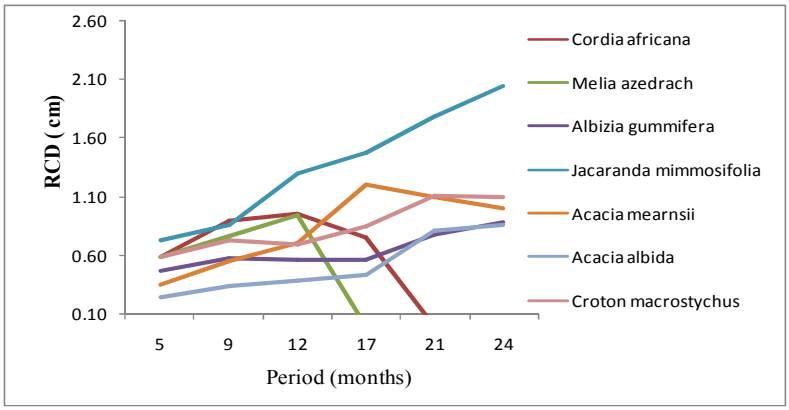

Figure 3. *Growth Root Collar diameter (RCD) at different time data recorded.*

4. Conclusion and Recommendation

Among tree species tested in the rehabilitation of termite degraded areas, *Jacaranda mimosifolia, Melia azedarach* and *Acacia albida* are the most promising tree species tested in rehabilitation of termite degraded area. Though *Acacia mearnsii, Cordia africana* and *Albizia gummifera* showed low survival rate in rehabilitation of termite degraded areas, but *Cordia africana* and *Albizia gummifera* it were dominant indigenous tree species in the study area. Besides indigenous tree species, but *Cordia africana*, *Albizia gummifera* and *Croton macrostychus* were low survival rate to compared to growing of exotic tree species like, *Jacaranda mimosifolia* and *Melia azedarach* in the rehabilitation of termite degraded areas could help rehabilitation of the study area. Generally, studies are recommended to examine the contribution of tested species to soil improvement, rehabilitation and identify additional native and exotic species suitable for rehabilitation of termite degraded areas.

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