International Journal of Scientific Research and Engineering Development-– Volume 6 Issue 6, Nov- Dec 2023

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Performance of Multipurpose Trees under Integrated Termite Management of Dogano Dumuga site, Oromia Region, Western Ethiopia

Temam Mama[1], Zebene Asfaw (PhD)[2]

[1]Temam Mama, Haro Sabu Agricultural Research Center, Oromia, Ethiopia

[2] Zebene Asfaw (PhD), Hawassa University Wondo Genet College of forestry and natural resource

Corresponding author: temammama@gmail.com

Abstract

This research was carried out in Dogano Dumuga, Oromia, Ethiopia, in the Kellem Wollega zone. The objective of this study was to evaluate the growth performance of some selected multipurpose tree species at termite affected area. A termite-affected area of 128m x 48m was purposefully chosen for this study, and seedlings of *G. robusta*, *C. macrostachyus*, *J. mimosifolia*, *M. azedarach*, and *O. africana* were randomly assigned to an area and out planted on a 20m*40m treatment plot. The space between plots of each species was 4m and, 2m Spacing between rows and within row was used for each species. In each treatment plot, *B. humidicola* grass was sown with no tillage. On the space between plots, a physical soil and water conservation structure (soil bund) was built. In order to fit the given objectives the tag was given with its corresponding numerical code to seedlings within plots of each tree species and; data on height, root collar diameter, survival percentage was collected on 11.1, 23.4, 34.6 and 45.3 months from each tree within plots except the border. Data on tree survival percentages were separately subjected to ANOVA and Tukey's HSD tests were used to examine the results at p=0.05 to discover differences among tree species in their survivals. The relative growth rate in height of tree species was plotted using data collected on seedling height (RGR). The results showed that the overall survival rate of the tree species was high, ranging from 65.97 percent (*C. macrostachyus*) to 76.03 percent (*G. robusta*) at a given location. *G. robusta* and *J. mimosifolia*, on the other hand, grew faster in height than the other species.

Keywords: Survival Percentage, Relative Growth Rate (RGR), Integrated Termite Management

1. INTRODUCTION

In western Ethiopia, particularly in the west and Kellem Wollega zones of Oromia, termite damage has gotten worse (Negese *et al*., 2017, ICRA., 1998 and Hailu *et al*., 2018). By eating a variety of field and plantation crops, woods, rangelands, and woody items (H. Taye et al. 2013), they significantly contribute to soil degradation by leaving it barren and susceptible to erosion. Spectacular termite activity can occasionally lead to almost complete denudation (Abraham, 1990 and Kit et al., 1998). The Macrotermitinae subfamily and the genera Macrotermes, Microtermes, Odontotermes,and Pseudacanthotermes are the termite species that have been identified as pests in western Ethiopia; however, only Macrotermes has been found to be the most destructive in several areas of the Wollega and Asosa administrative regions (Abdulahi, 1990). Macrotermes can be seen foraging in plant roots, stem bases, crop stalks, and woody debris that is spread out on the soil's surface. They also create small dome-shaped mounds of soil. Crop stalks, plant roots, stem bases, and woody litter are all present on the soil's surface.

There have been few studies on the growth performance of multipurpose trees in termite-affected areas. The growing efficiency of multipurpose trees on termite-affected areas, however, may differ depending on the tree type, according to another study (Kayleigh et al., 2013). As a result, some tree species may thrive more in compacted soils rich in termites than in uncompacted soils. On the other hand, Mugerwa et al. (2014) study in the study area recommend integrated termite management measures, including providing termites with adequate food resources, reducing crop vulnerability through improved agricultural water and soil nutrient management, and integrating repellent organisms (like vetivar grass) in cropping and pasture systems may deter termites from attacking crops and helps for vigorous growth, thereby enhancing rehabilitation of termite-degraded areas. Termite damage to crops can be reduced by using mulch or other organic amendments, which can also improve plant growth and productivity.

Regarding the termite species found at an area, more research is necessary, however according to other studies, the growth performance of multipurpose trees may have an impact on the termite infestation of a region. As trees mature, termite infestation may increase, but if a strong canopy is created, attacks are often significantly reduced (Daniel, G.D., 2020).

The main issue causing land degradation and affecting agricultural productivity at the region of research site is widespread termite infestation (Negese *et al*.,2017 and Haile *et al*.,2018). The Agricultural Development Office, Sustainable Soil Management Project, and Ethiopian Evangelical Church Mekane Yesus have made efforts to address this issue by planting *G. robusta*, *C. macrostachyus*, *J. mimosifolia*, *M. azedarach*, and *O. africana* trees on degraded land in the district (LKBOA Annual report. 2019).The maximum termite damage up to complete loss of those planted tree species have been documented at an area,

notwithstanding efforts made by the players in the study region. Therefore, evaluating how well trees perform under specific integrated termite control strategies may contribute to offering useful knowledge about their uses for various organisms in the research area in particular as well as for making wise policy decisions generally.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The study was conducted at Dogano Dumuga peasant association of Lalo kile district, Kellem Wollega zone, Oromia, Ethiopia (Figure 1). It is situated between 8°52'00''N - 8°54'30''N and 35°20'30''E - 35°24'00''E, and within the altitudinal range from 1400-2000 m.a.s.l. The district has a total area of 40,382 hector and 97% Kola and 3% Woyena Dega agro-ecology (Olani *et al*, 2016). The area's annual temperature varies from 15°C to 31°C with annual average temperature of about 23°C and the annual rainfall ranging from 900-1800 millimeters. It gets mean annual rainfall of about 1050 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.

Laboratory result of composite soil sample of an area shows that, the soil of the study area wasreddish brown. The textural classof thesoil was sandy clay loam and pHof 5.28. Compratum Spp, pillistigama thonningi, *Acacia Spp*, and *Ficas sycomors* are some of the many vegetation types present in the district. People with a mixed agricultural system rely on agriculture for their livelihood, and livestock play an important role in agriculture (LKBOA Annual report. 2019).

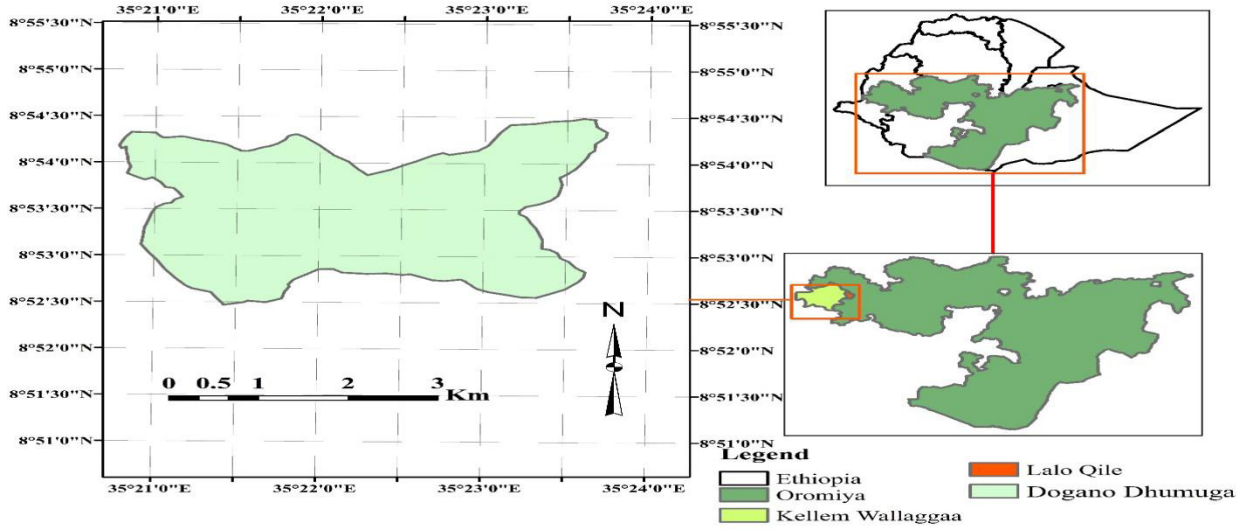

Figure 1.Map of the study area.

2.2. Experimental design

A total termite degraded area of 128m x 48m was purposively selected, from Lalo Kile district at specific site named "Dogano Dumuga". Seedling of *G. robusta, C. macrostachyus, J. mimosifolia, M. azedarach* and *O. africana* were randomly assigned to an area and out planted on plot of 20m*40m. The space between plots of each species was 4m and, 2m Spacing between rows and within row was used for each species.

2.2.1. Management practices

Before the implementation of the research some mound observed on the selected site was drilled using drilling material (auger) and poisoned with chemical (Chetozone). Termite tolerant grass (*Bracharia humidicola*) locally known as 'Coommoo' was sown in each plots of trees by broadcast method with zero tillage without disturbing the existing plant and soil structure that tree species was planted on. Soil and water conservation structure (soil bund) was done in space between plots of each species. Conservation Agriculture was also promoted through encouraging crop residue retention in an area. Again hoeing of seedlings was carried out to facilitate seedlings growth.

2.3. Data collection

2.3.1. Tree parameter

To determine and compare growth performance of trees (height, root collar diameter, survival percentage) in integrated termite management practice of an area, the tag was given with its corresponding numerical code to seedlings within plots of each tree species and Growth parameter data of trees was collected on 11.1, 23.4, 34.6 and 45.3 months from each tree within plots except the border.

2.4. Statistical analysis

Data on survival percentage of trees were separately subjected to ANOVA to determine differences among tree species in their survivals. Tukey's HSD test was employed for Multiple Comparisons when significant differences were found between tree species (p= 0.05). The statistical procedures were carried out by Minitab 17 software package.

Data collected on seedlings height and root collar diameter were used to plot the relative growth rate in height (RGRH) and root collar diameter(RGRRcd). The relative growth rate in height and root collar diameter for each tree species was calculated following the procedure by Ibrahim *et al*., (2003):

Height; RGR (%): $((H_1-H_0)/$ time in years) *100

Where: H_0 is the initial plant height in (cm),

H_1 is the plant height in (cm) on any given observation date.

Root collar diameter; RGR (%): $((Rcd_1-Rcd_0)/$time in years)*100

Where: Rcd_0 is the initial plant root collar diameter in (cm),

Rcd_1 is the root collar diameter in (cm) on any given observation date.

3. RESULT AND DISCUSSION

3.1. Growth parameter of Tree Species

3.1.1. Survival

Analysis of variance for species survival were non-significant (P>0.05) among the species at the study site (Fig.2). Mean survival of tree species was high on all tree species. It was ranging from 65.97% (*C. macrostachyus*) to 76.03 % (*G. robusta*). Data on the survivals of those tree species in integrated termite management practices of termite affected area is limited. However, these results may show good survivals of trees as compared with that reported by (Dawit, 2017), sole plantation of multipurpose trees on area that similarly affected by termite. For instance, survival values of *Jacaranda mimosifolia* (75.83) , *M. azedarach* (68.8) and *C. macrostachyus* (65.97) were 3.4, 1.9 and 4.6 times greater than survival value obtained by (Dawit, 2017) respectively. These higher values may relate to positive influences of integrated termite management practice (ITM). (Mugerwa *et al*. 2014) reported that integrated termite management practices can reduce vulnerability of crops to termite through improved agricultural water and soil nutrient management for survival and vigorous growth. Crop wastes may also increases the organic matter content of the soil and reduces termite count per plant, according to a study by (H. Taye *et al*. 2013), study on integrated termite management in degraded crop land in Diga district.

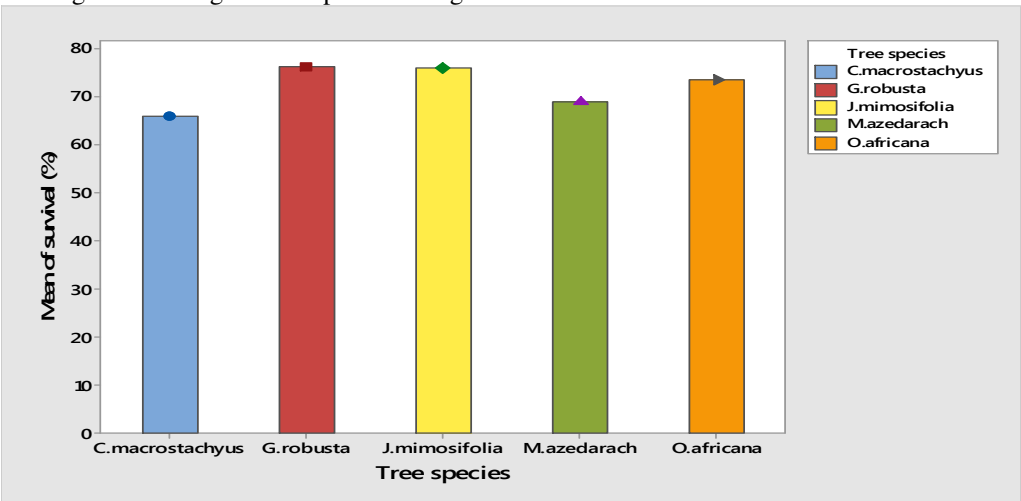

Figure 2.Mean values of survival percentage of tree species observed at study site.

3.1.2. Relative growth rate of height

The relative height growth rate of tree species during three measurement period of 11.1 months to 23.4months (368 days); 23.4 months 34.6 months (336 days); 34.6 months and 45.3 months (322 days) was relatively different at the site (Fig.3). Accordingly, *G. robusta* and *J. mimosifolia* showed higher increasing trend but at decreasing rate than the rest of species. For example, growth rate of *G. robusta* during the first phase, second and third phase were about 0.273 %, 0.327 % and 0.567 %, respectively. However, in terms of growing trend with no diminishing trend, C. macrostachyus and M. azedarach had the slowest height growth rates. According to Azene (2007), the fastest growing tree species are *G. robusta* and *J. mimosifolia*, while *C. macrostachyus* and *M. azedarach* are fairly rapid growers. Regarding the termite species found at an area, more research is necessary, however according to other studies, the growth performance of multipurpose trees may have an impact on the termite

infestation of a region. As trees mature, termite infestation may increase, but if a strong canopy is created, attacks are often significantly reduced (Daniel, G.D., 2020).

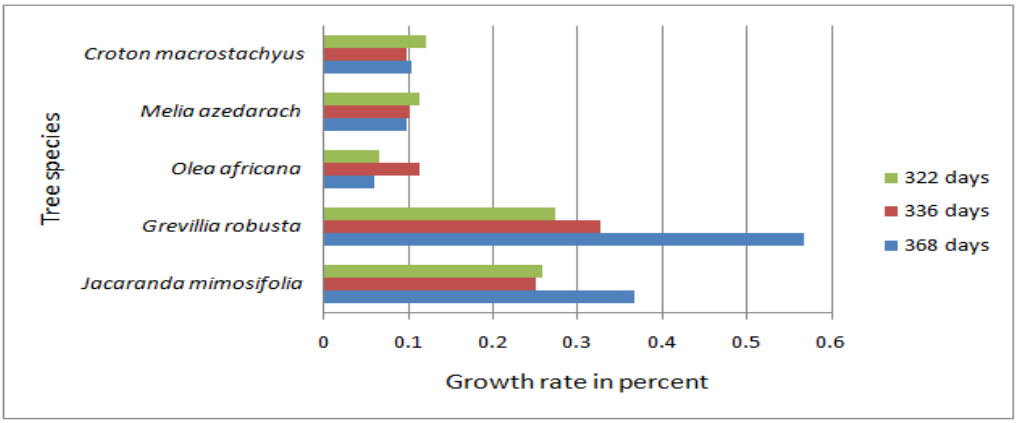

Figure 3.Height growth rate (in percent) of multipurpose tree species during three measurement period of 11.1 months to 23.4(368 days) ; 23.4 months 34.6 months (336 days); 34.6 months and 45.3 months (322 days) at the study site.

3.1.3. Root Collar Diameter

The results of root collar diameter growth rate analysis for *G. robusta* and *J. mimosifolia* showed higher increasing trend but at decreasing rate than the rest of species. Again the root collar diameter growth rate of *C. macrostachyus* and *M. azedarach* was relatively higher in terms of increasing trend but with relatively lower decreasing rate. However the root collar diameter growth rate of *O. africana* was lower in terms of increasing trend but with no decreasing rate (Fig.4). In the current study, differences in the RCD of the five young tree species relatively in line with that of their relative height growth may contribute to overall growth performances of trees at an area.

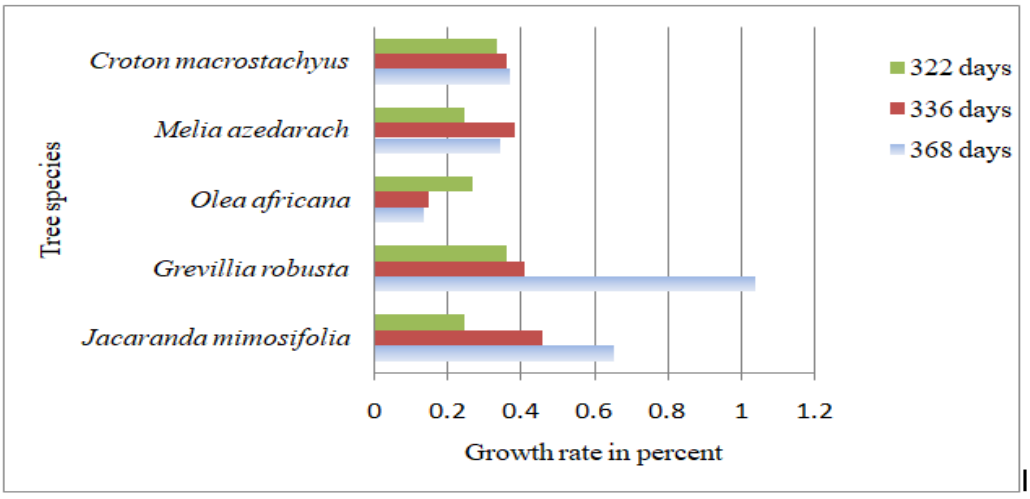

Figure 4.Root collar diameter growth rates (in percent) of multipurpose tree species during three measurement period of 11.1 months to 23.4(368 days) ; 23.4 months 34.6 months (336 days); 34.6 months and 45.3 months (322 days) at the study site.

4. Conclusion and Recommendation

The results of the present study indicate that survival percentage of tree species was high at the site ranging from 65.97% (*C .macrostachyus*) to 76.03 % (*G. robusta*). *G. robusta* and *J. mimosifolia* were faster in height growth rate than others. Under certain integrated termite management practice used at an area, such higher survivals trees, faster growth rates of *G. robusta* and *J. mimosifolia* could be a good implication to promising condition for termite infestation at a site. However, further work on the growth performance of those trees in further termite affected area of the zone along with both age increment of trees and site difference is important. Again, evaluating soil status under them is also required to know how this integration contributes to fertility of an area so that termite effect on soil degradation could be minimized.

Acknowledgements

I acknowledge my debt of gratitude to the Oromia Agricultural Research Institute for funding us to do our research. We would like also to express our sincere gratitude to "Haro Sebu Agricultural Research Center (HSARC)," for providing me necessary support including vehicles and other materials.

5. REFERENCE

Abdurrahman Abdullah. 1990. Forage activity and control of termites in western Ethiopia. PhD. Thesis, University of London, 277pp

Abraham, T., 1990, February.Termites: Problems and possible methods of their control in agriculture with reference to the Ethiopian condition.Preceeding of the 10th Annual meeting of the Ethiopian Entomologists (pp.50-74).

Azene Bekele Azene Bekele-Tesemma. 2007. Useful trees and shrubs of Ethiopia: Identification, Propagation andManagement for 17 Agro climatic Zones.RELMA in ICRAF Project World Agroforestry Centre, East Africa Region, Nairobi Kenya.

Dawit Samuel. 2017. Initial Growth Responses of Multipurpose Tree Species Under Termite Infested Areas at Mana Sibu District of West Wollega Zone, Oromia Regional State, Ethiopia. *American Journal of Life Sciences* Vol. 5, No. 5, pp. 134-139.

Daniel, G.D., 2020.Economic importance of termites and integrated soil and water conservation for the rehabilitation of termite-degraded lands and termite management in Ethiopia. *Journal of soil science and environmental management*, *11*(2), pp.65-74

Dix, M.E., Bishaw, B., Workman, S.W., Barnhart, M..R.,Klopfenstein, N.B. and Dix, A.M., 1999.Pest Management in Energy and Labor-Intensive Agroforestry Systems. *Sustainable Agricultural Systems*

Hailemichael Taye, Kees Swaans, Hirpha Legesse, Dereje Fekadu, Negash Geleta and Don Peden, (2013).Uptake of integrated termite management for the rehabilitation of degraded land in East Africa: A research into use baseline study in Diga, Ethiopia. Nile BDC Technical Report 6 Nairobi, Kenya: ILRI.

Hailu, A., Kisi, K. and Sida, A., 2018. Characterization and Analyses of Farming System in the Major Agro-Ecology of West Wollega Zone, Oromia National Regional State of Ethiopia.In *Regional Review Workshop on Completed Research Activities* (p. 206)

Ibrahim M, Aref LI, El-Juhany, Said SH. 2003. Comparison of the growth and biomass production of six acacia species in Riyadh, Saudi Arabia after 4 years of irrigated cultivation. Journal of Arid Environments.PP: 783-792.

ICRA (International Center for Development Oriented Research in Agriculture). 1998. A Participatory Systems Analysis of the Termite Situations in West Wollega, Oromia Region, Ethiopia. Working Document Series (68), Wageningen, the Netherland.

Kayleigh Muller and David Ward.2013.Direct and indirect effects of termites on savanna tree-seedling growth.Plant Ecology Vol. 214, pp: 811-819

LKBOA. Lalo-kile district bureau of agriculture. Annual report. 2019.

Kit V., Gizachew, L., Julius, A.O., Negeri, M.and Devendra, G., 1998.Participatory system analysis of the termite situation in West Wollega, Oromia Region, Ethiopia.

Mugerwa, S., Mpairwe, D.R., Zziwa, E., Swaans, K. and Peden, D.G., 2014. Integrated termite management for improved rainwater management: A synthesis of selected African experiences.

Olani A, Bekele D (2016).Epidemiological Status and Vector Identification of Bovine Trypanosomosis in Lalo Kile District of Kellem Wollega Zone, Western Ethiopia. *J Vet Med Res* 3(2): 1045.

Negese W, Mosisa T, Sida A. Oromia Agricultural Research Institute, Haro Sebu Agricultural Research Center, Soil Fertility Improvement and Soil Water Conservation Research Team, PO. Box 10, Haro Sebu, Kellem Wollega Zone, Oromia Regional state, Ethiopia.

Units and Abbreviations

Cm----------Centimeter
ICRA----------International Center for development oriented Research in Agriculture
ITM---------- Integrated Termite Management
RCD----------Root Collar Diameter
RGR---------- Relative Growth Rate
RGRH----------Relative Growth Rate of Height
RGRRcd----------Relative Growth Rate of Root collar diameter.

