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Growth Performance of *Moringa stenopetala* and *Moringa oleifera* Species at Adola Rede District, Guji Zone, Southern Ethiopia

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Abstract

The study was conducted at Adola Rede District, Guji Zone, in Southern Ethiopia for three consecutive years from 2018-2020. The objective of the study was to evaluate the growth performance of two Moringa species namely Moringa Stenopetala and Moringa oleifera for midland agroecology of Guji Zone. The experiment was replicated three times in a randomized complete block design (RCBD). The Moringa seedlings were out planted in a plot size of 7mx7m. Space between seedlings and plots were 2.5m and 2m respectively. On each plot nine Moringa seedlings were planted. Based on the objective of this study, growth parameters such as survival rate, tree height, root collar diameter and diameter at breast height was recorded during the study time. The finding of this study showed that survival rate of the two moringa species was significantly different starting from at the age of two years. The highest survival rate 88.7% was recorded from Moringa stenopetala and survival rate of Moringa oleifera was 77.7% at the age of three years. The results of current study showed that there was a significant difference ($p<0.05$) in Height growth, Root collar diameter and Diameter at breast height (DBH) was observed among the two Moringa species. The maximum tree height was recorded from Moringa stenopetala (4.41m) and the minimum tree of 2.21m was recorded from Moringa oleifera species. The highest root collar diameter and diameter at breast height of Moringa stenopetala was 7.9cm and 4.42 cm respectively. However, the minimum root collar diameter and diameter at breast height of Moringa oleifera was 6.2cm and 2.46cm respectively. Based on the results of three years growth parameters collected data, growth performance of Moringa stenopetala species is promising and hence it can be considered for further promotion of this multipurpose tree species at midland agroecology of Guji Zone and for sites with similar agro-ecological conditions.

Keywords: Diameter at breast height, Moringa oleifera, Moringa stenopetala, Root collar diameter , Survival rate and Tree height

Introduction

Moringa is a tropical plant belonging to the family *Moringaceae* that grows throughout the tropics. The genus *Moringa* is represented by 13 different species, two of which are *Moringa oleifera* and *Moringa stenopetala* species (NRC, 2006). Among various types of Moringa species, *Moringa stenopetala* is native to Ethiopia, Northern Kenya and Eastern Somali and it is the most economically important species after *Moringa oleifera* (Olson, 2001). It is widely distributed in the Rift Valley of southern Ethiopia (Azene Bekele, 1993; Edwards *et al.,* 2000) and it is used as vegetable food for human consumption and animal feed resources during dry period (Abuye *et al.,* 2003).

Moringa oleifera is native to northern India but now cultivated throughout the tropics, especially in arid areas. It is a drought-resistant and valuable tree, introduced to Ethiopia long ago and now naturalized in many parts of Gamo Gofa, Harerge and in the Rift Valley and tried elsewhere. *Moringa oleifera* requires well drained soils with a high water table, but it is drought resistant and occurs at low altitudes in Dry and Moist lowlands agroclimatic zones (Azene Bekele, 2007).

The edible parts of the Moringa tree are exceptionally nutritious (Rams, 1994; Teketay, 2001). Leaf parts are promising as a food source in the tropics because the tree is full of leaves during the dry season when other foods are typically scarce (Fahey, 2005). Leaves of *Moringa stenopetala* are rich in protein (28.2-36.2%) and contain considerable amounts of essential amino acids (Melesse *et al.,* 2009; Negesse *et al.,* 2009).

Moringa species are known as good nutrition sources and because they are highly tolerant of very dry conditions, they are often used as important famine foods, especially for infants and nursing mothers (Mahmood *et al.,* 2010). In addition, the fresh leaves of *Moringa stenopetala* are cooked and eaten as a vegetable in Southern Ethiopia (Yesehak *et al.,* 2011). Moreover, the *Moringa stenopetala* leaves are widely used as a traditional herbal remedy by the local population (Mark, 1998).

Midland Agroclimatic condition of Guji Zone is very suitable for growing of Moringa multipurpose tree species. However, due to lack of adapted and improved Moringa species at Midland Districts of Guji Zone, Moringa trees are not yet diversified and local communities of the study area so far not benefited from this important multipurpose tree species. Thus, the present study was conducted to evaluate the growth performance of two Moringa species at Adola Rede District, Guji Zone, in Southern Ethiopia.

Materials and Methods

Description of the Study area

This study was conducted in Adola Rede District, in Guji zone, in Southern Ethiopia, which is located 468 km away from Addis Ababa to the South. The location of the District is between $5^{o}44'10"$N- 60^{0} $12'38"$N and $38^{o}45'10"$E - $39^{o}12'37"$E (Figure 1). It has a total area of about 1401km^{2}. Most topography of the District is characterized by ups and down arrangement. Moreover, it has land surface with an elevation ranging from 1500 to over 2000 meters. The major soil of the District is Nitosols (red basaltic soils) and Orthc Acrosols. The District is characterized by three agro climatic zones, namely high land, midland and lowland and the percentage coverage of each climate zones are highland (11%), midland (29%) and lowland (60%). The type of rainfall of the study area is bi-modal with longest rain season that has the maximum rainfalls which falls between 1200-1800mm annually and the shortest rainfalls records between 800-1200mm with an erratic distribution patterns.

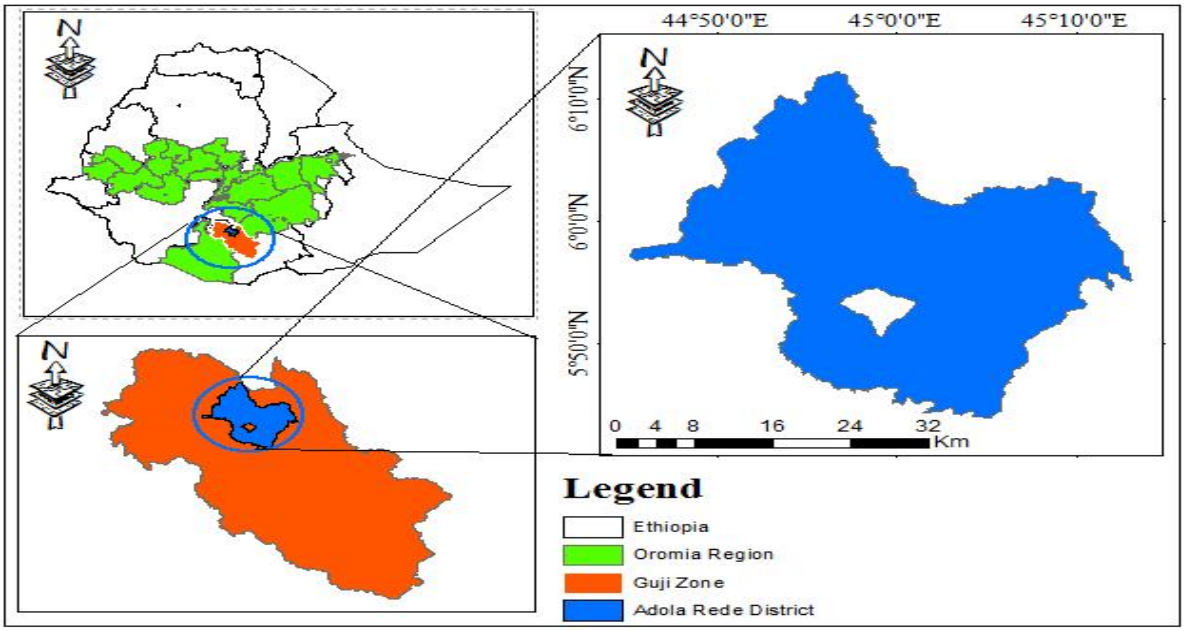

Figure 1: A map showing the study area

Treatments and Nursery Management

Seeds of two Moringa tree species namely *Moringa Oleifera* and *Moringa Stenopetala* included in this experiment (Table-1) were obtained from Central Ethiopia Environment and Forestry Research Center. Seedlings of the two Moringa tree species were raised at Adola Sub site. Sowing of seeds was done on seed beds and after germination the seedlings were pricked out in polythene tube diameter of 12cm. Optimum care, such as watering, mulching, shading and weeding were provided at the nursery site to produce healthy and vigorous seedlings for field planting.

Table 1. Origin, Distribution, Preservation status and Major uses of *Moringa stenopetala* and *Moringa oleifera* Species selected for the study

Moringa Species	Native to	Actual distribution	Preservation	Major Use
Moringa oleifera Lam.	Asia(India)	Sub tropical regions World wide	Endangered	Multipurpose
*Moringa stenopetala(*Bak.f.)Cuf	Africa(Ethiopia and Kenya)	Ethiopia, Kenya, Somalia	Endangered	Multipurpose

Plantation and Design of the Experiment

The seedlings of the two Moringa tree species were planted in Adola Rede District, at Adola Sub site of the center in 2018. The experiment was replicated three times in a randomized complete block design (RCBD). During plantation time, a plot size of 7mx7m was used. Space between seedlings and plots used were 2.5m and 2m respectively. On each plot nine Moringa tree species seedlings were planted.

Data collection and Analysis

Survival rate, Tree height, Root collar diameter and Diameter at breast height were the four growth parameters that were measured quarterly for three years. Survival percentage of each species was calculated as the number of trees surviving by the end of the experiment divided by initial tree number times 100. Height growth was determined by using measuring tapes, root collar diameter and diameter at breast height was measured by caliper.

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

Results and Discussion

Survival rate (%)

In terms of their survival rate, significant difference was not observed among the two Moringa species at the age of one year (Table 2). However, after one year establishment, survival rate of *Moringa stenopetala* species was significantly higher *(P<0.05)* than *Moringa oleifera* (Table 2). The survival rate of the two Moringa species at the age of three years under the present investigation showed that, survival rate of *Moringa stenopetala* species was higher (88.8%) and from *Moringa oleifera* only 77.7% survival rate was recorded(Table 2). In contrast to this study finding, at Bako, Western Oromia higher survival rate of *Moringa olifera*(100%) and 97.33% survival rate of *Moringa stenopetala* was recorded (Dawit *et al.*,2016). In addition, Musa and Bira (2020) indicated that in Harari Region, Ethiopia maximum 83.3 % survival rate of *Moringa oleifera* species was recorded. However, relatively similar to this study finding, in Northern Ethiopia 70.4% of survival rate was obtained from *Moringa Stenopetala* species (Abraham and Kidane, 2014).

Table 2. Survival rate and Tree height growth parameters of *Moringa stenopetala* and *Moringa oleifera* species over three years at Adola Sub site.

Moringa Species	Survival Rate (%)			Tree Height(m)		
	2018	2019	2020	2018	2019	2020
Moringa stenopetala	100[a]	92.4[a]	88.8[a]	2.95[a]	3.95[a]	4.41[a]
Moringa oleifera	100[a]	85.4[b]	77.7[b]	1.77[b]	1.95[b]	2.21[b]
Mean	100	88.9	83.25	2.36	2.95	3.31
LSD (5%)	0.00	14.35	13.72	0.152	0.165	0.172
CV (%)	0.00	3.8	3.9	14.21	14.6	11.3

**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 (m)

As the finding of this study indicated that, in height increment highly significant differences (P< 0.05) were observed among the two Moringa species during the study time. At the age of three years after establishment *Moringa stenopetala* had maximum heights of 4.41m and *Moringa oleifera* had minimum tree height of 2.21m (Table 2). However, the results of the current study is in contrast with (Korsor, M. *et al.*, 2019) indicated that in Central Namibia Semi-Arid Range land Environment the highest average height of 2.814 m was recorded from *Moringa oleifera* ascompared to *Moringa ovalifolia*. Moreover, the finding of this study is in contrast with Dawit *et al.*, 2016. On their study results showed that maximum height of 3.97m was recorded in *Moringa oleifera* and the minimum height of 2.63m was recorded in *Moringa stenopetala*.

Based on the finding of current study the recorded growth performance of *Moringa oleifera* in terms of survival rate and height increment was very low as compared to *Moringa stenopetala.* This could be due to *Moringa oleifera* species performed well at low altitudes in Dry and Moist lowlands agroclimatic zones, at altitude of 500–1,600 meters above sea level (Azene Bekele, 2007).

Table 3. Root collar diameter and Diameter at breast height growth parameters of *Moringa stenopetala* and *Moringa oleifera* species over three years at Adola Sub site.

Moringa Species	Root collar diameter (cm)			Diameter at breast height(cm)		
	2018	2019	2020	2018	2019	2020
Moringa stenopetala	3.75	6.4[a]	7.9[a]	2.85[a]	4.15[a]	4.42[a]
Moringa oleifera	2.95[a]	5.3[b]	6.2[b]	1.67[b]	2.12[b]	2.46[b]
Mean	3.35	5.85	7.05	2.26	3.13	3.44
LSD (5%)	1.13	2.14	2.56	0.78	1.87	2.12
CV (%)	8.34	11.35	12.21	9.23	12.6	13.3

**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)*

Root Collar Diameter (Cm)

The results of this study showed that, there is significant difference among the two Moringa species in root collar diameter growth rate was observed. Root collar Diameter of both *Moringa stenopetala* and *Moringa oleifera* species significantly different at the age of their establishment increased (Table 3). The highest root collar diameter growth rate (7.9cm) was recorded in *Moringa Stenopetala,* while it was low in *Moringa oleifera* species which was 6.2 cm. Many research findings indicated that tree species having the greatest root collar diameter increment which grown tallest. Therefore, similar correlation between height and root collar diameter growth of multipurpose tree species was reported (Tilahun *et al.*, 2006; Abebe *et al.*, 2000). Similarly the present study also showed that the *Moringa stenopetla* species which have highest root collar diameter is taller than *Moringa olifera* species based on their recorded height data. In line with the present study, research findings conducted in Gimbo District, South western Ethiopa revealed that at the age of *Moringa stenopetala* increased growth rate of root collar diameter also increased (Getahun *et al.*, 2017).

Diameter at breast height (cm)

The present study revealed that, growth in diameter at breast height also significantly different among the two *Moringa stenopetala* and *Moringa oleifera* species. As depicted in Table 3, diameter at breast height growth of the two Moringa species was significantly different *(at P<0.05)* starting from first year establishment. As the finding of this study indicated that, *Moringa stenopetala* has show high diameter at breast height (4.42cm), while the recorded diameter at breast height of *Moringa oleifera* species was 2.46 cm.

Conclusion and Recommendations

It can be concluded that the two Moringa species namely *Moringa stenopetala* and *Moringa oleifera* species showing promising performance under the environmental condition of Adola Rede District. However, when the two Moringa species compared each other in terms of their survival rate *Moringa stenopetala* was significantly higher than *Moringa oleifera*. The recorded tree height of the two Moringa species showed that, height growth of *Moringa stenopetala* was significantly higher than *Moringa oleifera* species. The maximum tree height recorded from *Moringa stenopetala* was 4.41m and the minimum tree height of 2.21m was recorded from *Moringa oleifera* species.

On the other hand, in terms of their root collar diameter and diameter at breast height growth parameters among the two Moringa species significant differences was observed. At the age of three years, the highest root collar diameter and diameter at breast height of *Moringa stenopetala* was 7.9cm and 4.42 cm respectively. However, the minimum root collar diameter and diameter at breast height of *Moringa oleifera* was 6.2cm and 2.46cm respectively during the third year of establishment.

Based on the finding of this study both of Moringa species are a multipurpose tree of significant economic importance as it has vital for nutritional, industrial and medicinal applications. Therefore, for local communities of Midland Agroecology of Guji Zone, *Moringa stenopetala* and *Moringa oleifera* species are recommended respectively for local communities of the study area and for sites with similar agro-ecological conditions.

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