

Research Article

Introduction and Evaluation of *Moringa oleifera* (Lam) Growth in Two Districts of Bale Zone, Oromia Region, Southeast Ethiopia

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Abstract

Moringa oleifera is one of the most important plants which has to be introduced, conserved and promoted for its social, economic and environmental benefits. Study was conducted aimed to introduce *M. oleifera* through evaluating its growth performance under the field condition of mid-altitude areas of Bale, Ethiopia. The experiment was laid-out using randomized complete block design with three replications on two locations. In the study the necessary plant growth traits namely survival rate, plant height and diameters (at breast height and root collar) were collected and analyzed by Genstat software. As to results except survival rate other growth performance traits of the studied species were statistically influenced by location in the subsequent years of monitoring period. With this, the mean value of survival rate recorded at Dello-menna was > 80% whereas at Goro it was < 80% throughout the years of study period. For plant height the recorded mean values were found between 65 cm to 370.30 cm and 58.30 to 296.70 cm range in the respective Dello-menna and Goro sites. Breast height diameter ranged from 0.747 cm to 6.533cm at Goro site and from 1.00 cm to 8.983cm at Dello-menna. In terms of root collar diameter, the values ranged from 1.933 cm to 9.867 cm and from 1.410 cm to 4.592 cm at Dello-menna and Goro sites, respectively. The values pointed that *M. oleifera* had showed a promising growth and development over both locations with relatively the higher performance at Dello-menna site than Goro. Therefore, the species could be demonstrated, promoted and scaled-up to the farming community of Dello-menna, Goro and other areas with similar agro-ecology. However, the nutritive value of the species in response to the studied locations has remained the focus of future research area.

Keywords

Diameter at Breast Height, Plant Height, Root Collar Diameter, Survival Rate

1. Introduction

Moringa oleifera (Lam) is a tropical flowering plant that belongs to the *Moringaceae* family, containing 13 diverse species [7, 17]. The plant is indigenous to south Asia where it grows in the Himalayan foothills from North-Eastern Paki-

stan to North-Western Bengal, India [10, 14, 16]. It is a fast growing, small to medium sized in height and an umbrella shaped crown with bi-(tri-) pinnate leaves, while the individual leaflets have a leaf area 1 - 2 cm². Flowers are white to

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Received: 19 April 2024; **Accepted:** 14 May 2024; **Published:** 11 September 2024



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cream colored and zygomorphic. The tree bears 20 to 40 cm long pod that once mature, change color from green to brown revealing numerous round or triangular seeds with three papery wings [4, 12].

Moringa oleifera goes many names in different parts of the world. In the Philippines, where the leaves of the moringa are cooked and fed to babies, it is called "mother's best friend" and "malunggay." Other names for it include the benzolive tree (Haiti), horseradish tree (Florida), Nébéday (Senegal) and drumstick tree by Indian's [11]. It can be grown in a wide variety of soil types with soil pH between 4.5 and 9.0 [5, 14]. However, it prefers well-drained soil conditions in the neutral pH range [7]. The plant grows well at altitudes from 0 to 1800 m and rainfall between 500 to 1500 mm per year [1, 6].

Overall, *M. oleifera* is one of the most important agroforestry plant species that could be introduced, conserved and promoted over a wide range of agro-climatic zone for its multitude environmental, social and economic benefits. It has a great potential to serve as a high-value food crop, source of medicinal products and as well as fodder for animals [7, 9, 15]. This implied *M. oleifera* is the cheapest and credible plant resource not only providing good nutrition, but also to cure and prevent a lot of diseases. Realizing this there is a growing interest for *M. oleifera* products despite the plant is still little known and valued in many African countries.

In Ethiopia *M. oleifera* is relatively rare in cultivation compared to *M. stenopetala* species. Instantly, the ongoing moringa plantation being undertaken in Bale is restricted only on *M. stenopetala* since no alternative species is introduced and advocated before in the area. This calls an effort to be made for alternative moring species introduction aiming for the diversification the resource base of the plant in the area. Studies suggested before planting any tree/shrub species in a given agro-ecology there is always the need of conducting a field trial for the suitability of the species [2, 3]. This because the adaptability and growth performance of woody perennials strongly dependent-up on climatic and soil conditions of a particular environment. Thus, study was designed and conducted to introduce *M. oleifera* species via evaluating its growth performance under the field condition of mid-altitude areas of Bale, southeast Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Goro and Dello-Menna research sub sites of Sinana Agricultural Research center. Dello-menna research sub site is located at 6° 24' 42.45" N and 39° 49' 55" E while Goro sub site lie at 6°59'20.97" N and 40°29'45.16" E. The rainfall pattern for both areas is bimodal type, which divide the year into two rainy seasons. Accordingly, Dello-menna have main rainy season middle of March through June and short rainy seasons early September through November.

The mean annual rainfall of Dello-menna district is about 986.2 mm with mean annual temperature of 22.5°C. Its altitude ranges from 1000 to 2500 meters above sea level with reddish brown clay soil type towards the higher altitudes and tending red-orange sandy toward the lower elevations [2]. Goro district attain the main rainy season June to October and short rainy season March to May. The mean annual rainfall for Goro is between 800 and 1000 mm with Mean maximum annual temperature 6.5°C and mean of minimum temperature 12.4°C. The soil condition of Goro is black clay type.

2.2. Experimental Design and Procedures

The potted seedling of the species was raised and produced at Oromia Forest and Wildlife enterprise tree nursery site of Dello-menna district following standard nursery cultural technique. Thereafter, two-months old seedlings of *M. oleifera* were transplanted and established on two experimental fields using randomized complete block design (RCBD) with three replications. The spacing between plants was 2 m x 2 m consisting 12 plants/plot.

2.3. Data Collection and Statistical Analyses

In the study, survival count, diameters (RCD and DBH) and height growth performance parameters were collected. Survival count was made for the whole tree/shrub species found within a plot whereas for the other parameters about six plants were randomly selected and used as source of data. Root collar diameter and DBH were measured using calipers whereas height was measured using graduated pole. Finally, the collected data analyzed by GenStat computerized software program.

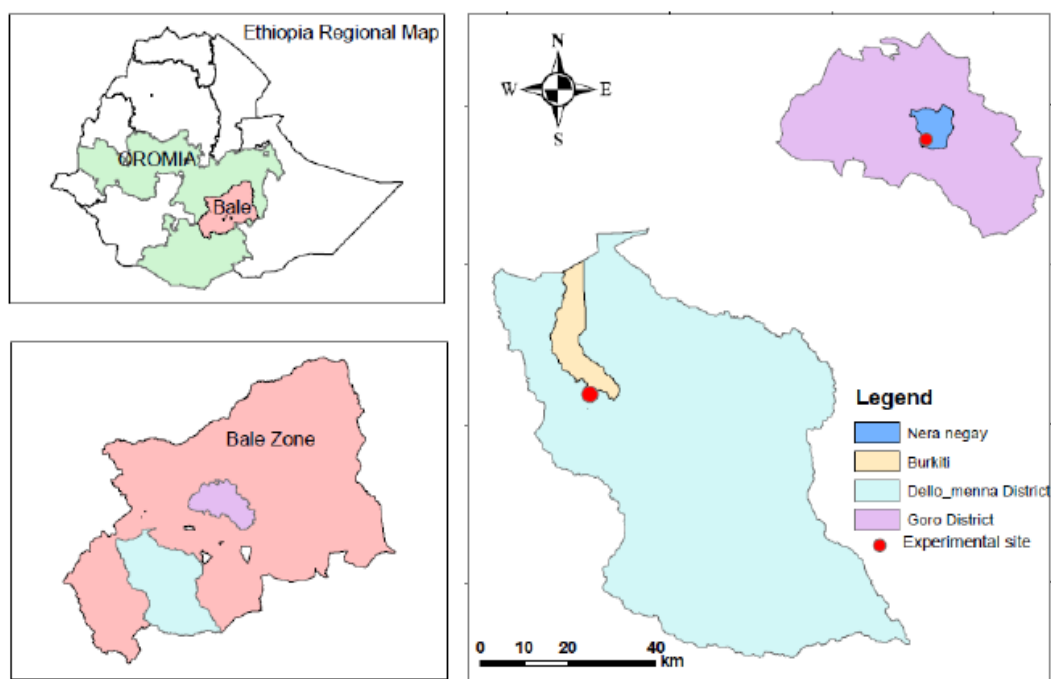


Figure 1. Location of the study area.

3. Results and Discussion

3.1. Survival

The result revealed that, survival rate of *M. oleifera* was influenced by location over the subsequent years of study period (Table 1). During the years the survival rate of the species was higher at Dello-menna compared to Goro. At Goro site the

recorded mean values were reported within a range of 61.11% to 75% over the years. Others related study conducted on screening of tree/shrub species survival rate under field condition by Gebrekidan Abrha *et al.* pointed species reported with > 50% survival rate could be considered for a wide range of tree plantation program [8]. Based on this, *M. oleifera* would be similarly considered and used for large scale plantation purpose over both current study areas.

Table 1. Survival rate (%) of *M. oleifera* as influenced by locations over the years of study period.

Locations	Years of study period				Mean
	1 st year	2 nd year	3 rd year	4 th year	
Dello-menna	96.30 ^a	88.89 ^{ab}	85.19 ^{abc}	81.48 ^{bcd}	87.48
Goro	75.00 ^{cde}	69.44 ^{def}	66.67 ^{ef}	61.11 ^f	68.05
Mean	85.65	79.165	75.93	71.29	77.76
CV (%)	9.50				
LSD (p<0.05)	13.00				
Sign	0.0398				

N/B: CV = Coefficient of variation, LSD = Least significant difference, Sign = Significance

3.2. Plant Height

During the 3rd and 4th years of study period plant height was significantly influenced by locations confirming the relative higher value at Dello-menna site than Goro. Accordingly, the plant height at Dello-menna found within a range

of 65.0 cm to 370.30 cm whereas at Goro experimental site it was reported between 58.30 cm and 296.70 cm in the years of monitoring period (Table 2). The range of mean values obtained in the current study are closely comparable with those reported by [13] in southeastern Kenya within a range of 50 cm to 400 cm.

Table 2. Plant height (cm) of *M. oleifera* as influenced by locations over the subsequent years of study period.

Planted sites	Years of study period				Mean
	1st year	2nd year	3rd year	4th year	
Dello-menna	65.00 ^{de}	120.00 ^{cd}	329.30 ^{ab}	370.30 ^a	221.15
Goro	58.30 ^e	140.00 ^c	174.70 ^c	296.70 ^b	167.43
Mean	61.65	130.00	252.00	333.50	194.30
CV (%)	16.20				
LSD (p<0.05)	55.11				
Sign	0.001				

N/B: CV = Coefficient of variation, LSD = Least significant difference, Sign = Significance

3.3. Root Collar Diameter

In the study, collar diameter growth of *M. oleifera* ranged from 1.41 cm to 7.267 cm at Goro and from 1.933 cm to 9.867 cm at Dello-menna in the frequent years of monitoring period (Table 3). This implied the higher collar diameter growth for the studied species is recorded at Dello-menna experimental site with 5.945 cm mean annual increment within a year.

Table 3. Root collar diameter (mm) of *M. oleifera* as influenced by planting sites over the subsequent years of study period.

Locations	Years of study period				Mean
	1st year	2nd year	3rd year	4th year	
Dello-menna	1.933 ^f	3.647 ^e	8.333 ^b	9.867 ^a	5.945
Goro	1.410 ^f	4.057 ^e	5.633 ^d	7.267 ^c	4.592
Mean	1.671	3.852	6.983	8.567	5.268
CV (%)	11.10				
LSD (p<0.05)	1.023				
Sign	<.001				

N/B: CV = Coefficient of variation, LSD = Least significant difference, Sign = Significance

3.4. Diameter at Breast Height

Similar to other growth performance traits breast height diameter (DBH) development was significantly ($p < 0.008$) influenced by locations during 3rd and 4th years of monitoring period (Table 4). The recorded mean values during the years were ranged from 4.81 cm at Goro to 8.98 cm at Dello-menna site.

Table 4. Diameter at breast height (cm) of *M. oleifera* as influenced by planting sites over the subsequent years of study period.

Planted sites	Years of study period				Mean
	1 st year	2 nd year	3 rd year	4 th year	
Dello-menna	1.000 ^e	2.223 ^d	6.490 ^b	8.983 ^a	4.67
Goro	0.747 ^e	2.607 ^d	4.817 ^c	6.533 ^b	3.67
Mean	0.873	2.415	5.653	7.758	4.17
CV (%)	15.60				
LSD (p<0.05)	1.142				
Sign	0.008				

N/B: CV = Coefficient of variation, LSD = Least significant difference, Sign = Significance

The lower survival and growth performance of *M. oleifera* at Goro attributed to the species intolerance to the water-logged soil condition of the studied site. The soil condition of Goro site is black clay type which is susceptible for water-logging during rainy season against to Dello-menna. Other related studies conducted by [5] also documented that the species is well adapted and grows best in well-drained sandy or loamy soil with a neutral to slightly acidic pH value range.

4. Summary and Conclusion

Moringa oleifera is one of the most important plants which has to be introduced, conserved and promoted for its multitude social, economic and environmental benefits. Study was planned and conducted to introduce *M. oleifera* plant via evaluating its growth performance based on survival rate, plant height, and collar and breast height diameters. The Study was conducted at Dello-menna and Goro research sub sites of Sinana Agricultural Research Center located in Bale zone, southeast Ethiopia. In the study, the mean value of survival rate at Dello-menna site was recorded within a range of 81.48% to 96.30%. At Goro, the values reported between 61.11% and 75% range during the years of study period. For plant height the recorded mean values found between 65 cm to 370.30 cm and 58.30 to 296.70 cm range at the respective Dello-menna and Goro experimental sites. Breast height diameter ranged from 0.747 cm to 6.533cm at Goro site and from 1.00 cm to 8.983cm at Dello-menna. In terms of collar diameter, the values ranged from 1.933 cm to 9.867 cm and from 1.410 cm to 4.592 cm at Dello-menna and Goro sites, respectively. Generally, *M. oleifera* had showed a promised growth and development over both locations confirming the better performance at Dello-menna experimental field compared Goro. The lower performance at Goro attributed to moringa species intolerance to the slight waterlogged soil condition of the studied site against to Dello-menna. To this end, *M. oleifera* could be demonstrated,

promoted and scaled-up to the farming community of current study areas and other with similar agro-ecology. However, the nutritive value of the species in response to the studied location has remained the focus of future research area.

Abbreviations

DBH	Diameter at Breast Height
RCBD	Randomized Complete Block Design
RCD	Root Collar Diameter

Author Contributions

Wondmagegn Bekele: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Bikila Mengistu: Supervision, Validation, Visualization, Writing – review & editing

Hirpha Abebe: Supervision

Conflicts of Interest

The authors declare no conflicts of interest.

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