Agriculture, Forestry and Fisheries
2024; 13(1): 1-7
http://www.sciencepublishinggroup.com/j/aff
doi: 10.11648/j.aff.20241301.11
ISSN: 2328-563X (Print); ISSN: 2328-5648 (Online)

Evaluation on Growth Performance of Moringa Stenopetala Provenance at Daro Lebu and Hawi Gudina Districts, West Hararghe Zone, Oromia, East Ethiopia

Shimelis Dekeba*, Alemayehu Diriba, Wasihun Gizaw, Mosisa Mezgebu

Mechara Agricultural Research Center, Mechara, Oromia, Ethiopia

Email address:
shimedekeba@gmail.com (Shimelis Dekeba), alemayhudiriba@gmail.com (Alemayehu Diriba)
*Corresponding author

To cite this article:
Shimelis Dekeba, Alemayehu Diriba, Wasihun Gizaw, Mosisa Mezgebu. (2024). Evaluation on Growth Performance of Moringa Stenopetala Provenance at Daro Lebu and Hawi Gudina Districts, West Hararghe Zone, Oromia, East Ethiopia. *Agriculture, Forestry and Fisheries*, *13*(1), 1-7. https://doi.org/10.11648/j.aff.20241301.11

Received: November 27, 2023; **Accepted**: December 28, 2023; **Published**: January 11, 2024

Abstract: Six Moringa stenopetala provenances (Abay Filklik, Arbaminch, Gofa, Wolayita, Konso and Babile) were examined for survival and growth parameters at Daro Lebu and Hawi Gudina districts since 2019. This study was undertaken with randomized complete block design with four replications. At age of three year; survival rate, tree height, diameter at breast height (DBH), root collar diameter, canopy diameter (CD) and fresh leaf biomass were assessed. The result indicated that at Daro Lebu, there were significance ($P < 0.05$) among provenances; in their survival rate, height, root collar diameter, and fresh leaf biomass, but DBH and canopy diameter did not show statistical difference. Survival rate showed significant difference between provenances at Daro Lebu; while at Hawi Gudina site there was no significant difference. Survival rate at Daro Lebu ranged from 50% for M.Gofa and M.wolayita while, M.babile was 83.33%. At Hawi Gudina site survival rate was 91.67% for M.abay Filiklik and 100% for M.konso, M.arbaminch and M.wolayita. All provenances in both sites except M.gofa, M.gofa and M.konso at Daro Lebu had survival rate above 66%. At Daro Lebu, M.abay Filiklik demonstrated superior mean height (2.53 m) followed by M.babile (2.09 m) and M.wolayita (1.2 m) is the shortest provenance. At Hawi Gudina site, M.arbami demonstrated superior mean height (2.32m) followed by M.konso (2.3 m) and M. babile (1.57 m) were the shortest provenance. M.gofa demonstrated superior RCD (99.17 mm) followed by M.babile (98 mm), while M.wolayita (61.09 mm) shown the lowest performance at Daro Lebu. While, at Hawi Gudina site site, M.arbaminch demonstrated superior RCD (138.67mm) followed by M.konso (135.42 mm); while M.babile (107.09 mm) shown the lowest performance. At Daro Lebu, M.babile demonstrated superior fresh leaf biomass (1.61 kg) followed by M.gofa (1.59), while M.wolayita (0.48 kg) shown the lowest performance. At Hawi Gudina site, M.gofa demonstrated superior fresh leaf biomass (3.11 kg) followed by Wolayita (2.91 kg), while M.babile (1.34 kg) shown the lowest performance. Owing to superior growth performances attained, M.babile, M.gofa and M.konso be recommended for Daro Lebu and similar agro-ecology, while M.arbaminch, M.gofa and M.konso for Hawi Gudina and similar agro-ecology.

Keywords: Daro Lebu, Fresh Leaf Biomass, Growth Performance, Hawi Gudina, Moringa Provenance, Survival Rate

1. Introduction

Moringa stenopetala belongs to family Moringaceae that is characterized solitary by a single genus Moringa. The genus Moringa is characterized by 14 diverse species to which *M.stenopetala* belongs [8]. M. stenopetala cultivates in the wild hip elevations between 1,000 and 1,800 [10] but from particular explanations the species cultivates as high as 2200 m.a.s.l and as low as 300 m (herbarium sources) in Ethiopia.

Moringa is drought resilient and can be grown in a wide diversity of poor soils, even barren ground, with soil pH between 4.5 and 9.0 [7]. The species is informal to imitate and its development is very fast that have higher growing international attention due to its social, economic and environmental significance which can benefit humans and animals nutritionally, economically and as a dynamism source. Moringa is an essential nourishment source in many countries. For example Moringa stenopetala leaves are the main food of the Konso people in Ethiopia [6].

M. stenopetala is habitually denoted as the East African Moringa tree since it is native to southern Ethiopia and northern Kenya only [10]. However; it cultivates in many other parts of the tropics, it is not as widely known as its nearby qualified, M. oleifera of India, but frequently measured generally more required than M. oleifera [8]. According to [4], *M. stenopetala* is a tree 6-12 m tall; trunk: more or less 60 cm in diameter at breast height; crown: strongly branched sometimes with several branches; thick at base; bark: white to pale gray or silvery, smooth; wood: soft; leaves: up to 55 cm long; inflorescence: pubescent, dense many flowered panicles 60 cm long. Optimal light for germination of all Moringa species is half shade. Seeds could be planted about 2 cm deep in soil that is moist but not moreover wet. The sprouting occurs typically in 1-2 weeks. It can be permissible to be cultivated for shade (6-15 m), or kept low (about 1-1.5 m) for easier harvesting [8].

The gardening of *Moringa stenopetala* in Ethiopia occurs mostly in the southern zones of the country and special districts such as South Omo, Gamo Gofa, Kaffa, Sheka, Bench Maji, Wolaita, Dawaro, Bale, Borena, Sidama, Burji, Amaro, Konso and Derashe [4]. The recurrent types of Moringa are paramount with many production imitations, such as a relatively long period to bear fruit, non-availability of planting materials, requirement for long rainy period in regions where water is rare and susceptibility to pests and diseases [5, 11]. The numerous native fodder trees and shrubs irritating in shortened tannins including *M.stenopetala, which* is considered as nutritionally possible feed supplements under small holders farming scheme in the tropics [16].

Moringa is grown In Ethiopia as a courtyard crop in the southern parts of the country including Rift Valley and adjoining lowlands for its edible leaves, flowers and tender pods. The leaf of Moringa is actual common vegetable in Southern Nations and Nationalities and Peoples Regional State of Ethiopia that treasured for its superior headband. It is cultivated as courtyard tree to be taken as a daily food intake accessible more than for six million households of Southern Ethiopia [5]. Moringa has fascinated massive consideration of ethno-botanists and preservationists of plant genetic resources due to its extensive uses in agriculture and medicine.

Among the wide range of uses it provides are human food, fuel wood, livestock forage, medicine, dye, water purification, soil and water conservation, quality of cooking oil, green manure and the tree is used as source of income for Moringa growers [3, 9].

M. stenopetala is particularly important as human food because the leaves, which have high nutritional value [1], appear towards the end of the dehydrated season when few other sources of green vegetables are available. The leaves contain high amounts of essential amino acids and vitamins A and C [1]. Even though Moringa is fast growing; drought tolerant and certainly modified to deprived soil and dehydrated conditions, it has not acknowledged with significant research devotion to first-rate and advance impending ecotypes that might be treasured for both of gardening and remedial crops [13]. Now a days, some rural households in Hararghe area use Moringa for veterinary and other utility.

A needs for the *M. stenopetala* is increasing by livelihood as a result of its utility however, it's not access in case of limited amount of species and lack of identification more adaptation provenance supported with research at study area. Despite its more significant contributions to livelihood, *M. stenopetala* has not been given due research on provenance at study area to establish and expanded its species. At the study area, there are gabs between amount of Moringa contribution and needs of livelihood because of not given attention to expanded amount of *M. stenopetala* with its usage.

The information about genetic development, suitable executive and consumption of this valuable and versatile tree species is restricted. One of the means to overwhelm the problems is to evaluate diverse provenances of this species with a view of recognizing the provenances in order to maximize productivity. Hence, the present study is intended with an objective to evaluate different Moring stenopetala provenance and select the best adapted provenance in Western Hararghe Zone.

2. Literature Review

2.1. Favorable Condition for Moringa Stenopetala Growth

M. stenopetala can be grown at elevations from 390 - 2,200 meters. It grows best in areas where annual temperatures are within the range of 25 - 35°c, but, can tolerate 15 - 48°c. Plants can tolerate light frosts; even heavier frosts do not always kill the plant since it is able to sprout from the base. It prefers a mean annual rainfall in the range 500 - 1,500mm, but tolerates 200 - 2,800mm. Grows best in a sunny position, but tolerates light shade. It prefers a well-drained soil with a high groundwater table, but it can also withstand dry conditions well, and consequently it is found in both wetlands and dry areas. It prefers a pH in the range of 6 - 8, tolerating 5- 9. Plants are very drought tolerant; remaining green and continuing to grow even during exceptionally long dry season [14].

2.2. Importance of Moringa Stenopetala Alley Cropping/Intercropping

Moringa is indispensable crops due to fast growth, long taproots, few lateral roots, marginal shade and large amount of biomass yield that resulted with high protein content. Moringa trees are one of paramount Multipurpose Tree aspirants for utility of alley cropping systems. Conventionally, Moringa species is grown in mixed multi-story outlooks with food crops. For example, around Arba Minch, farmers planted it in their botanical gardens mostly 5 and sometimes up to 15 Moringa trees per 0.1 ha. Agriculturalists are practiced permanent multistoried cultivation with *M. stenopetala* at the uppermost level with papaya, coffee and bananas; in the upper-middle level with cassava, maize and sugar cane; in the lower-middle level with cotton and in the lowest level with pepper [8].

2.3. Socio-Economic Values

The financial prominence of an individual per income in low lands of southern Ethiopia is closely attendant with the number of *Moringa stenopetala* (Haleko) trees they have in their courtyard. For example, when a young man intends marriage in the former administrative region of Gamo Goffa of the South Ethiopia, the girl's (bride) family queries whether or not he/ husband would be has (Haleko) or Moringa trees in his farm [5].

As observed by [3] in some parts of southern Ethiopia, particularly among the Konso people that the plenty of Moringa species in the garden or on farmland was an indication of the social prestige owner among the society. The one with many Moringa trees in the garden or on farmland had a higher social prestige and he was also considered as a wealthy person. Among the various uses of *M. stenopetala* are animal feed, fertilizer, honey production, life fencing, customary remedial and pollution control [8, 12].

2.4. Season and Planting Method

Moringa is multiplied either by stem (limb) cuttings or by seed. In recurrent types, limb cuttings 100-150 cm in length with a diameter of 14-16 cm are planted *in situ* during the rainy season. Best trees are cut down, leaving a stump with a 90 cm head from which 2 to 3 branches are permissible to grow. From these shoots, cuttings 100 cm long and 4 to 5 cm in diameter are titled and castoff as planting material [2].

The branch cuttings are planted in pits of 60x60x60 cm at a spacing of 5x5 m, during the months from June to August. The monsoon rains during the period enable easy rooting and extra advance. While planting, one-third of the cutting should be kept inside the pit. Under moderate clay situations, watering should be done just moreover optimal levels to sidestep root rot. The seeds of annual Moringa may be directly dibbled in the pit to safeguard enhanced and earlier growth of the sprouts. The best appropriate season for sowing the seeds is March to August in Southern Ethiopian conditions. The time of sowing has to be severely followed because the flowering phase should not concur with the rainy seasons, which consequences in substantial flower shedding. A plant spacing of 2.5x2.5 m between rows and plants should be accepted, giving a plant population of 1600 plants ha^{-1}. The seed germinates takes 10 to 12 days after sowing. The seed prerequisite per hectare is 625 g. When planted in single row laterally with irrigation channels, a spacing of 2 m is sufficient. Treatment of Moringa seeds with Azospirillum cultures at the rate of 100 g per 625 g of seeds before sowing ensued in initial germination and increased seedling vigor, growth and yield.

The most common method of propagating M. stenopetala is by direct sowing without pre-treatment of seed. But standard nursery raised seedlings are also commonly used. Removing the spongy seed coat improves germination. In a nursery it needs 7-10 days to germinate. Use of wide polythene is advised as the bulgy root requires large enough space (12 cm diameter flat). In about 3 months the seedlings will be ready planting. Some farmers occasionally propagate the species by using branch-sized cuttings [8]

2.5. Origin of Moringa Stenopetala

M. stenopetala is frequently mentioned as the East African Moringa tree because it is innate to southern Ethiopia and northern Kenya only [10]. However it grows in many other parts of the tropics; it is not as widely known as its close relative, *Moringa oleifera* of India, but frequently measured commonly more wanted than it.

3. Materials and Methods

3.1. Climatic Description of the Study Area

The trial was conducted at Daro Lebu and Hawi Gudina districts. The elevation of Hawi Gudina is 1453 m.a.s.l. Rainfall pattern in the both location is bi-modal; Daro Lebu district recieved on average during *belg* rainy season (February 26, March 90, April 157 and May 128mm) and *kiremt* rainy season (June 101, July 144, August 158 and September 127mm) and also Hawi Gudina receive on average during *belg* rainy season (February 32, March 31, April 145 and May 328mm) and *kiremt* rainy season (June 26, July 168, August 46 and September 98mm figure 1). Average annual rainfall amount is 1120 mm at Daro Lebu district and 992mm at Hawi Gudina (Figure 2). Mean annual temperature is 21°C with mean annual minimum temperature of 15°C and maximum 28°C Daro Lebu district while, at Hawi Gudina mean annual temperature is 23°C with mean annual minimum temperature of 16°C and maximum 20°C [15].

3.2. Seed Source (Provenance) and Procedure of Treatment

Six (6) M. *stenopetela* provenances were studied in both site which were brought from, Abay Filklik, Arbaminch, Gamo Gofa, Wolayita, Konso and the local (Babile). Potted seedlings of the provenances were raised with polythene tube at Daro Lebu nursery using standard cultural techniques (Forest Division, 1982). The trial sites were manually cleared and land tilled followed by and pitting (pit size: 30 x 30 cm).before seedling planting. Planting was done in July 2019 at Daro Lebu and Hawi Gudina sites respectively. Weeding was done three times during the rainy season and once during the dry season

3.3. Experimental Design

Randomized Complete Block Design (RCBD) was used for the six provenances of *M. stenopetala* (treatment species) with four replications. The sizes of the plots was 4m*2m = ($8m^2$) and per plot six (6) trees were planted with 2m*2m spacing. The spacing between plots and blocks were 3m.

Sixteen (16) plots at one trial site were prepared while 96 trees were planted at total areas of 25m*17m = (425m^2) on each trial site.

3.4. Data Collection

Assessment was carried out at 3rd year after planting for variables such as; survival, root collar diameter 30 cm above ground (RCD), height (H), canopy diameter, diameter at breast height (DBH) and leaf biomass. Leaf biomass production was measured at final assessment. Height was measured using calibrated height measuring pole and canopy were measured using tape meter while RCD and DBH were measured using caliper.

3.5. Data Analysis

The collected data were analyzed with analysis of variance (ANOVA) following the General Linear Model (GLM) procedure using Statistical Analysis Systems (SAS Inst. Inc., 1991). The important variation, mean separation using, LSD of result indicator were conducted at 5 % point of significance level.

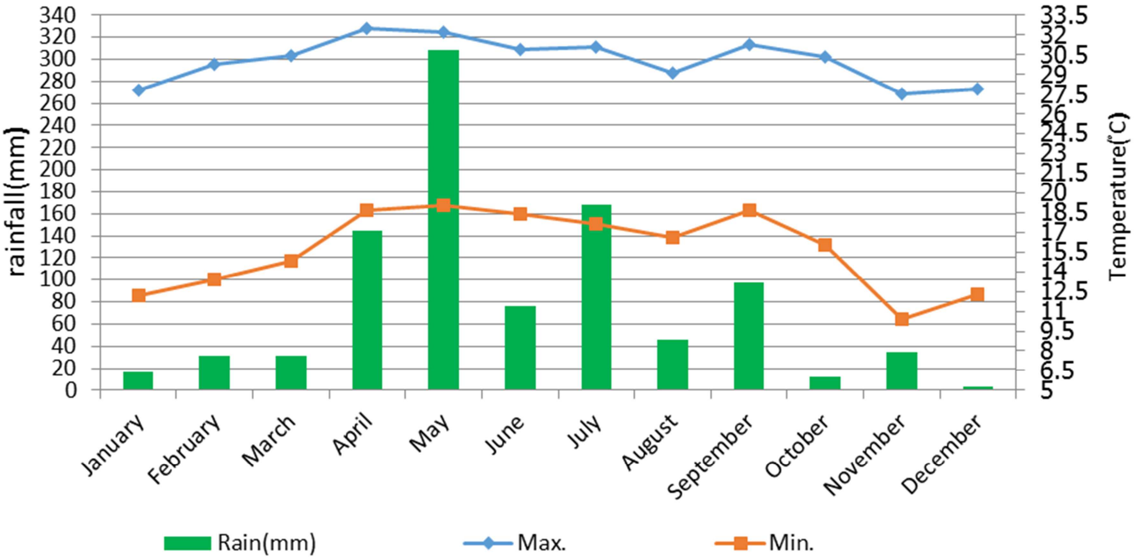

Figure 1. *Mean monthly rainfall amount, Mean minimum temperature and Mean Maximum Temperature at Hawi Gudina.*

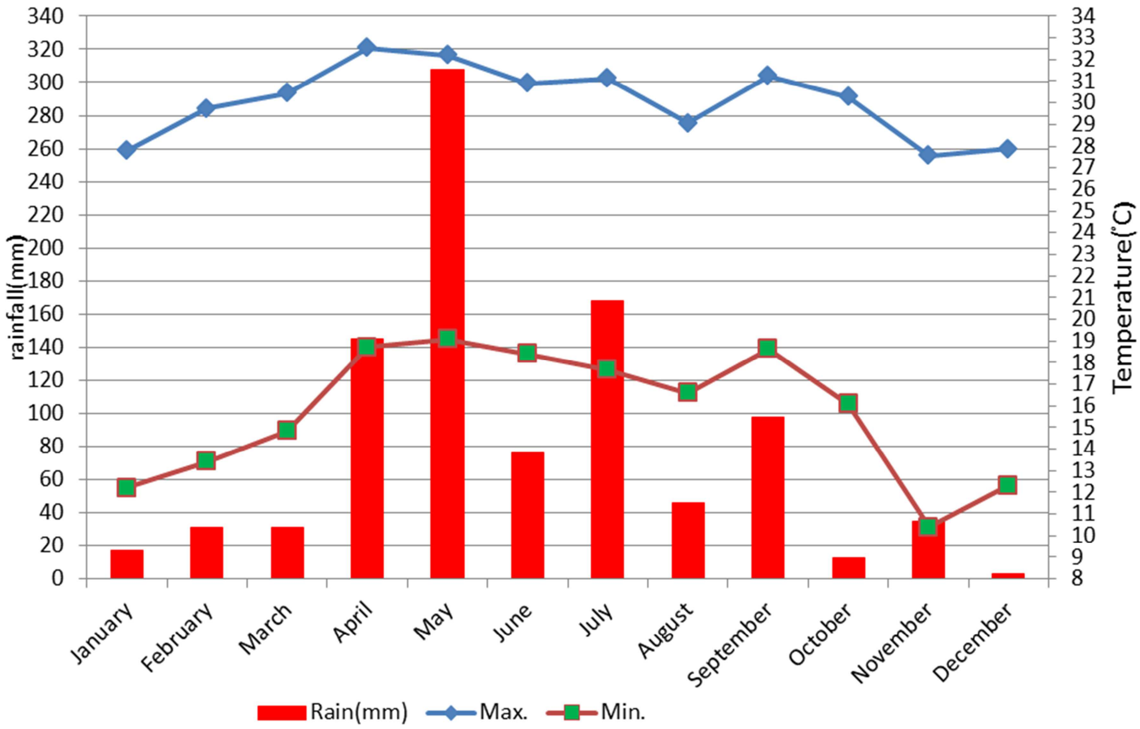

Figure 2. *Mean monthly rainfall amount, Mean minimum temperature and Mean Maximum Temperature at Daro Lebu.*

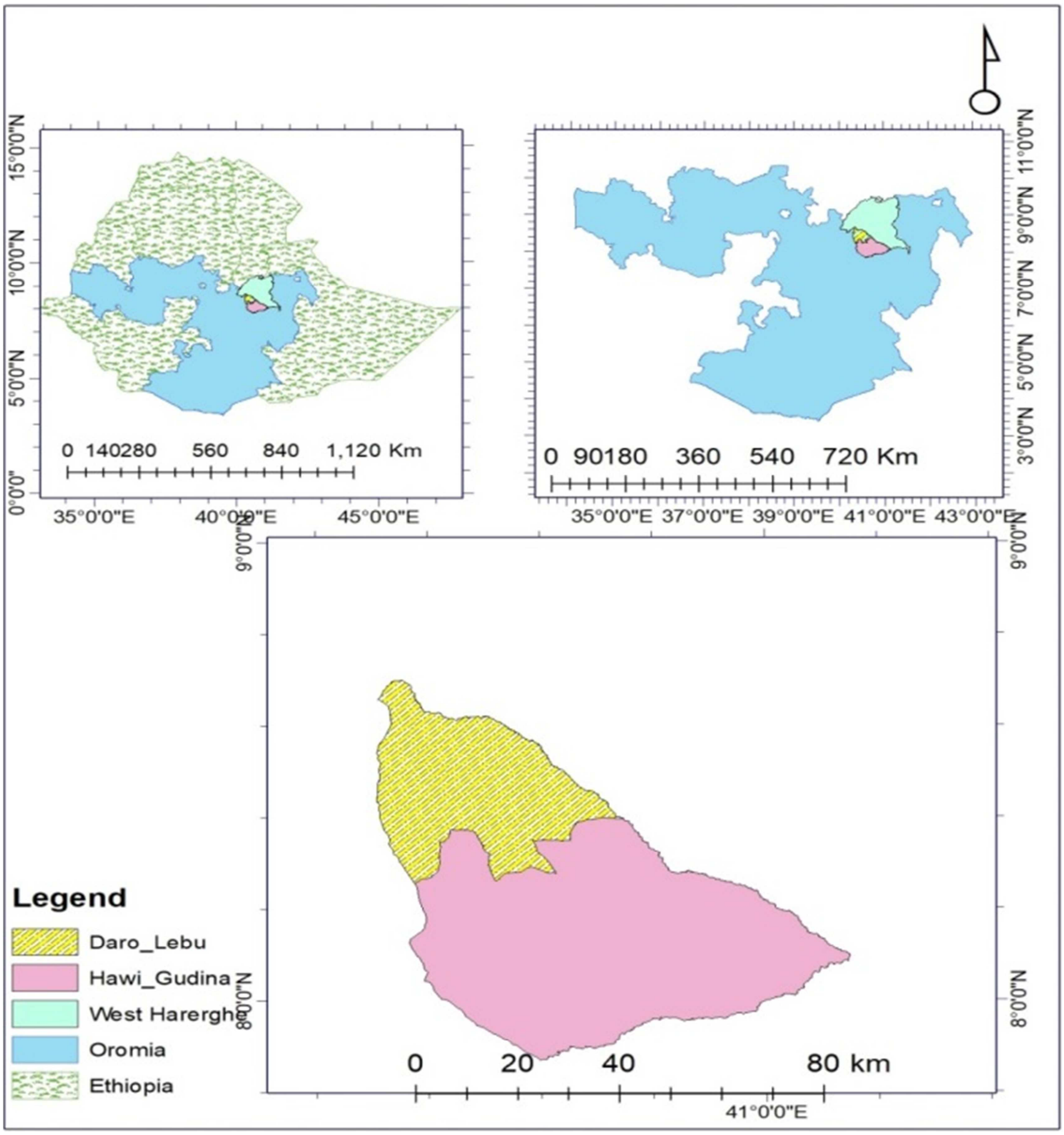

Figure 3. *Map of the study area.*

4. Results and Discussion

4.1. Survival Rate

Survival rate showed significant difference between provenances at Daro Lebu; while at Hawi Gudina site there was no significant difference. Survival rate at Daro Lebu ranged from 50% for M. Gofa and M.wolayita while, M.babile was 83.33%. At Hawi Gudina site survival rate was 91.67% for M.abay Filiklik and 100% for M.konso, M.arbaminch and M.wolayita. All provenances in both sites except M.gofa, M.gofa and M.konso at Daro Lebu had survival rate above 66%.

Table 1. *Means of survival rate, height, Diameter at breast height, Root collar diameter, Canopy diameter and Fresh leaf Biomass increment for M. stenopetela provenance trial at age 3 at Daro Lebu.*

Provenances	SR (%)	H (m)	DBH (mm)	RCD (mm)	CNP (m)	FLB (kg)
M.abay Filiklik	66.67(13.61)bc	2.53(0.27)a	30.84(2.88)	90.75(13.21)a	0.95(0.2)	0.72(0.03)bc
M.arbaminch	75(9.62)ab	1.57(0)d	18.59(9.2)	85.42(1.39)a	1.25(0.38)	0.79(0.05)bc
M.babile	83.33(0)a	2.09(0.09)b	28.75(2.5)	98(4.74)a	1.03(0.22)	1.61(0.23)a
M.gofa	50(19.25)d	1.78(0.24)cd	27.29(9.92)	99.17(6.31)a	1.38(0.36)	1.59(0.58)a
M.konso	56.25(4.17)[cd]	1.97(0.25)bc	32.67(9.52)	85.58(14.84)a	1.29(0.31)	0.98(0.43)b
M.gofa	50(0)d	1.2(0.23)e	29.38(7.08)	61.09(7.04)b	0.77(0.15)	0.48(0.21)c
Mean	63.54	1.86	27.92	86.67	1.11	1.03
PV	0.0006	<.0001	0.227	0.0004	0.051	0.0004

Provenances	SR (%)	H (m)	DBH (mm)	RCD (mm)	CNP (m)	FLB (kg)
LSD	14.37	0.309	11.839	13.918	0.4162	0.477
CV	15	11.047	28.14	10.66	24.83	30.791

*Values in parenthesis are standard errors. Means with of the same letter within the same column are not significantly different. Significant (P < 0.05) ns = Not significant (P > 0.05). SR=Survival Rate, H=Height, DBH= Diameter at Breast Height, RCD= Root Collar Diameter, CD=Canopy Diameter and FLB=Fresh Leaf Biomass.

Table 2. *Means of survival, height, Diameter at breast height, Root collar diameter, Canopy diameter and Fresh leaf Biomass increment for M. stenopetela provenance trial at age 3 at Hawi Gudina site.*

Provenances	SR (%)	H (m)	DBH (mm)	RCD (mm)	CNP (m)	FLB (kg)
M.abay Filiklik	91.67(9.62)	2.07(0.28)	52.71(20.87)	105(17.71)	2.15(0.29)	2.03(0.42)bc
M.arbaminch	100(0)	2.32(0.32)	43.92(7.67)	138.67(14.43)	2.04(0.23)	2.72(0.53)ab
M.babile	95.83(8.34)	1.57(0.21)	41.04(8.64)	107.09(24.28)	1.61(0.13)	1.34(0.44)c
M.gofa	95.83(8.34)	2.25(0.18)	39.5(10.06)	126(32.87)	2.14(0.42)	3.11(0.69)a
M.konso	100(0)	2.3(0.45)	39.92(15.47)	135.42(32.25)	1.89(0.4)	2.71(0.17)ab
M.wolayita	100(0)	2.2(0.8)	33.25(26.78)	107.25(29.71)	1.95(0.57)	2.91(1.07)ab
Mean	97.22	2.12	41.72	119.9	1.96	2.47
PV	0.3759	0.22	0.6271	0.2557	0.1576	0.018
LSD	9.55	0.670	23.004	38.07	0.445	1.006
CV	6.52	20.99	36.58	21.07	15.05	27.05

Means of individual provenance with standard error in parenthesis. Means of the same letter within the same column are not significantly different. Significant (P < 0.05) ns = Not significant (P > 0.05). SR=Survival Rate, H=Height, DBH= Diameter at Breast Height, RCD= Root Collar Diameter, CD=Canopy Diameter and FLB=Fresh Leaf Biomass.

* M.abay Filiklik =Moringa abay filikilik, M.arbaminch=Moringa Arbaminch, M.babile=Moringa Babile, M.gofa=Moringa gofa, M.konso=Moringa konso and M.wolayita=Moringa wolayita*

4.2. Height Growth

The highest height (2.53m) was scored by the provenance from M.abay Filiklik and the shortest (1.2 m) by the Wolayita provenance for Daro Lebu. At Hawi Gudina the highest one is Arbaminch (2.32 m) and the shortest one is Babile (1.57) provenance respectively. The differences in height growth within a site could be attributed to variations in adaptability among provenances while the between site differences in growth relate with agro climate differences between the two sites. Generally, the provenances showed good performance in height development at Hawi Gudina.

4.3. Diameter at Breast Height

There was no significant difference among the provenances in DBH at both sites. Though there were not significant, the M.konso(32.67) tree provenance had the greatest mean DBH followed by M.abay Filiklik(30.84) (Table 1) at Daro Lebu, while the greatest mean DBH for Hawi Gudina is M.abay Filiklik (52.71) and the least DBH is for M.wolayita (33.25) provenance.

Although there is no significant variation in DBH at Hawi Gudina site all provenances showed good performance in DBH development. All provenances gave comparable diameters when measured at year three.

4.4. Root Collar Diameter

Root collar diameter (RCD) was significantly different between coppice levels ($p < 0.05$) only at Daro Lebu s, which ranged between M.wolayita 61.09 mm and 99.17 mm for M.gofa provenance (Table 1). Though there is no significant difference in RCD at Hawi Gudina site; the highest RCD were recorded for M.arbaminch (138.67 mm) provenance (Table 2). The differences in RCD development within a site could be attributed to variations in adaptability among provenances, but generally the provenances at Hawi Gudina site showed good performance in RCD development.

4.5. Canopy Diameter

At both sites provenances did not differ significantly in canopy diameter. Canopy diameter at Daro Lebu ranged from 0.77 m for M.wolayita to 1.38 m (Table 1) for M.gofa and 1.61 m for M.babile to 2.15 m for M.abay Filiklik (Table 2) provenance respectively.

4.6. Fresh Leaf Biomass

Fresh leaf biomass was significantly different between provenances ($p < 0.05$) at both sites (Tables 1 and 2).Fresh leaf biomass at Daro Lebu ranged from 0.48 kg for M.wolayita to 1.59 kg for M.gofa and, while for Hawi Gudina site 1.34 kg for M.babile to 3.11 kg for M.wolayita provenance, respectively. Most provenances grown at the Hawi Gudina site showed high production of fresh leaf biomass than those grown at Daro Lebu. This could be due to agro-ecological variation between these sites. The lowest fresh leaf biomass at Daro Lebu was recorded from M.wolayita; while at Hawi Gudina site was recorded for M.babile provenances. This poor performance could probably be due to poor genetic adaptations influenced by climatic conditions in this area.

5. Conclusions and Recommendations

In Ethiopia, Moringa has been growing as a courtyard crop in the southern parts of the country including Rift Valley and adjacent to lowlands for its edible leaves, flowers and loving pods. The leaf of Moringa is the actual prevalent vegetable in Southern Nations and Nationalities and Peoples Regional State of Ethiopia and respected for its superior flavor. Knowledge about genetic improvement, proper management and utilization of this valuable multipurpose tree species is limited. One of the means to overcome the problems is to evaluate different provenances of this species with a view of identifying the provenances that maximize productivity. Hence, the present study is initiated with an objective to evaluate different Moring stenopetala provenance and select the best adapted provenance in Western Hararghe Zone

There was significant difference between provenances in their survival, height, root collar diameter, and fresh leaf biomass, but DBH and canopy diameter did not show statistically significant variation at Daro Lebu.

The current study has showed statistically significant variation among moringa provenances in their survival, height, root collar diameter, and fresh leaf biomass, but DBH and canopy diameter did not show statistically significant variation at Daro Lebu. At Hawi Gudina, there was significant difference between provenances only in fresh leaf biomass. The study revealed that, at Daro Lebu the most promising provenances are M.babile, M.gofa and M.konso whereas at Hawigudina, M.arbaminch, M.gofa and M.konso. The authors have recommended M.babile, M.gofa and M.konso provenance for Daro Lebu and similar agro-ecology, while M.arbaminch, M.gofa and M.konso provenances for Hawi Gudina and similar agro-ecology for further production.

The further research should focus on genetic improvement, nutrient analysis and evaluate the compatibly of these provenances with other crops in agroforestry system.

Acknowledgments

We are very grateful to IQQO for funding this research project. We are also strongly indebted to the support provided by Mechara Agricultural Research Center and all the staff specially, Agroforestry team members for their tireless effort in making the work a success.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Abuye, C., Urga, K., Knapp, H., Selmar, D., Omwega, A. M. and Imungi, J. K. (2003), "Acompositional study of Moringastenopetalaleaves", East African Medical Journal, Vol. 80.

[2] Bezabeh, K., 1993. Other medicinal uses of Moringastenopetala. Agrofor. Today, 5: 18-18. CWS. 2000. Moringa: The Miracle Tree. CSA, Dakar, Senegal.

[3] Demeulenaere, E. 2001. Moringastenopetala, a subsistence resource in the Konso district. Proceedings of the International Workshop Development Potential for Moringa Products, October 29-November 2, 2001, Dar-Es-Salaam, Tanzania, pp: 2-29.

[4] Edwards, S., M. Tadesse, S. Demissew and I. Hedberg. 2000. Flora of Ethiopia and Eritrea, Volume 2, Part 1: Magnoliaceae to Flacourtiaceae. Addis Ababa University, Ethiopia, Uppsal, Sweden, pp: 660.

[5] Endeshaw, H. G. 2003. Promoting the Miracle Tree of Hope. Ethiopian Herald. Addis Ababa University, Ethiopia.

[6] Ezekiel, E., Shabani, A. O. C., Yonika, M. N., & Mathew, A. M. (2014). Survival, growth and biomass production of Moringa oleifera provenances at Gairo inland plateau and Ruvu Coastal Region in Tanzania. African Journal of Plant Science, 8(1), 54–64. https://doi.org/10.5897/ajps12.158

[7] Fuglie, L. J. 2003. The Moringa tree a local solution to malnutrition. Dakar, Senegal.

[8] K. Yisehak, M. Solomon and M. Tadelle. 2011. Contribution of Moringa (Moringastenopetala, Bac.), a Highly Nutritious Vegetable Tree, for Food Security in South Ethiopia: A Review. Asian Journal of Applied Sciences, 4: 477-488.

[9] Malesse, A., Tiruneh, W., Negesse, T. (2011). Effects of feeding Moringa stenopetala leaf meal on nutrient intake and growth performance of Rhode island red chicks under Tropical climate. Tropical and Subtropical Agroecosystems 14: 485- 492.

[10] Mark, E. O. 1998. Research on applied uses of Moringastenopetala. FAO Technical Bulletin No. 4. http://www.berfingen.info/akababi/simon.htm.

[11] Price, M. L., 1985. Fruits and others: Articles the moringa tree. Tropical seeds.

[12] Rajangam, J., R. S. A. Manavalan, T. Thangaraj, A. Vijayakumar and N. Muthukrishan, 2001. Status of production and utilisation of Moringa in southern India. Development Potential for Moringa Products, October 29-November 2, Dar Es Salaam, Tanzania. http://www.moringanews.org/actes/rajangam_en.doc.

[13] Tenaye, A., E. Geta and E. Hebana, 2009. A multipurpose cabbage tree (Moringastenopetala): Production, utilization and marketing in SNNPR, Ethiopia. ActaHorticulturae, 806: 115-120.

[14] Tropical Plants Database, Ken Fern. Tropical.theferns.info.2018-12-18. tropical. theferns.info/viewtropical.php?id=Moringa+stenopetala

[15] Wasihun Gizaw (2021 un Published). Historical Rainfall Amount and Temperature Variability and Trend in West Harerhge Zone, East Ethiopia

[16] Yisehak, K., D. Belay and G. Janssens, 2010. Indigenous fodder trees and shrubs: Nutritional and ecological aspects. 14th European Society of Veterinary and Comparative Nutritition. ESVCN, Zurich, Swizerlands.