

Effect of Pollarding on Growth and Leaf Biomass Production of MoringaoliferiaLamin Arba MinchZuriyaWoreda, Southern Ethiopia

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Abstract
Moringa oleifera is native to northern India and planted in many parts of the world. In Ethiopia, little is known about the management and silvicultural practices of the plant. The present study was conducted to determine whether different cutting/pollarding heights affect the yield and growth of Moringa oleifera at Arba Minch Zuriya Woreda, Southern Ethiopia from November 2016 and September 2019. Two months old hardened twenty-five seedlings of the tree were planted at 5m x 5m plot at a spacing of 1mx1m. Four pollarding treatments/cutting heights (0.5m, 1.0m, 1.5m and 2.0m) and one control (un-pollarded) were imposed after 12 months of planting using randomized complete block design (RCBD) with three replications. Data were collected from 6 inner row individual Moringa trees from each plot. Data on the fresh and dry weight of leaf biomass per tree was taken at the age of 15, 18, 22, 26, 29 months after planting. Fresh wood biomass and the number of shoots rejuvenated after pollarding were also recorded. ANOVA was employed to analyze the collected data. Cutting height affected shoot number and height significantly ($P < 0.05$). A maximum number of shoots per plant was recorded on un-pollarded treatment (control). Cutting height affected fresh and dry biomass of leaf significantly ($P < 0.05$). Maximum fresh leaf biomass (823g/tree) was recorded at a lower pollarding height (0.5 meters) followed by 1.5 meters (729g/tree). The lowest fresh leaf biomass was recorded on un-pollarded treatment (268g/tree). Maximum and minimum dry leaf biomass was also obtained at 0.5-meter cutting height (222g/tree) and control (73g/tree) respectively indicating pollarding importance to the tree planted for foliar biomass production. Future research is recommended focusing on long-term growth and management trial of the species.
Keywords: Cutting height, Fresh Leaf Biomass, Moringa oleifera
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Introduction

Moringa (Moringa oleifera Lam) is a tropical plant belonging to the family Moringacea. It is native to India (Panga, 2002) and planted in many parts of the world (morthon, 2021) (Morton 1991; Makkar and Becke, 1996).It is adapted to a wide range of soil types and can tolerate dry season reasonably well but grows best in well-drained soils and cannot withstand prolonged waterlogging (Orwaet al., 2009). Moringa can be propagated either by using seeds or cuttings (Morton, 1991). M. oleifera is a multipurpose tree of significant economic importance. It is considered as one of the World's most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes (Khalafallaet al., 2000). M.oleifera was found to contain many essential nutrients, for instance, high sources of vitamins, calcium, potassium, and protein (Fahey 2005; Hsu et al., 2006; Kasoloet al., 2010).

Moringa oleifera was introduced to Ethiopia recently as a vegetable tree for its edible leaves and still remains unpopular despite its importance. One of the factors required for optimum and quality leaf production of Moringa is proper silvicultural management. For instance, Sanchez (2006) recommended 50 to 75 plants per square meter and cutting the leaf every 75 days for intensive biomass production in Nicaragua. Growers in Ethiopia, therefore, need to increase their leaf production by adopting appropriate techniques which will lead to sufficient and reliable leaf production without depleting the natural resource base. Many studies have been conducted that contributed to enhancing Moringa leaf production elsewhere (e.g, Sanchez 2006; Sanchez et al., 2006; Adebayo et al, 2011; Ezekiel et al., 2013). Despite all these studies, there is little scientific information in Ethiopia as the requirements for management tend to vary across regions and among agroecology. Thus, this warrants further empirical investigation on Moringa plant management to get information about the effects of pollarding height on biomass production. The objective of the present experiment was to determine the effects of four pollarding heights on biomass production in Arba Minch Zuriya woreda under high density planting.

Materials and Methods

Location of Experimental Area

The study was conducted at Chano Mille substation from 1st October 2016 to 30th September 2019. The study site is found in Arba Minchzuria District of Gamo zone, southern Ethiopia. The study area is geographically located at 6° 5′ 30″ N, 37° 35′ 0″ E with an altitudinal range of 1200 m above sea level. Meteorological records reveal that the rainfall pattern in Arba Minch Zuria is bimodal with mean annual rainfall ranges between 1100 mm - 1600 mm, whereas the minimum and maximum air temperature varying between 17 and 35 oC. The soil of the study site is characterized by clay loam texture and a landscape of gentle slope. Some other soil physio-chemical characteristics of the study site and the ratings are presented in table (1). The rating was done with the help of a publication by Hazelton and Murphy (2007).

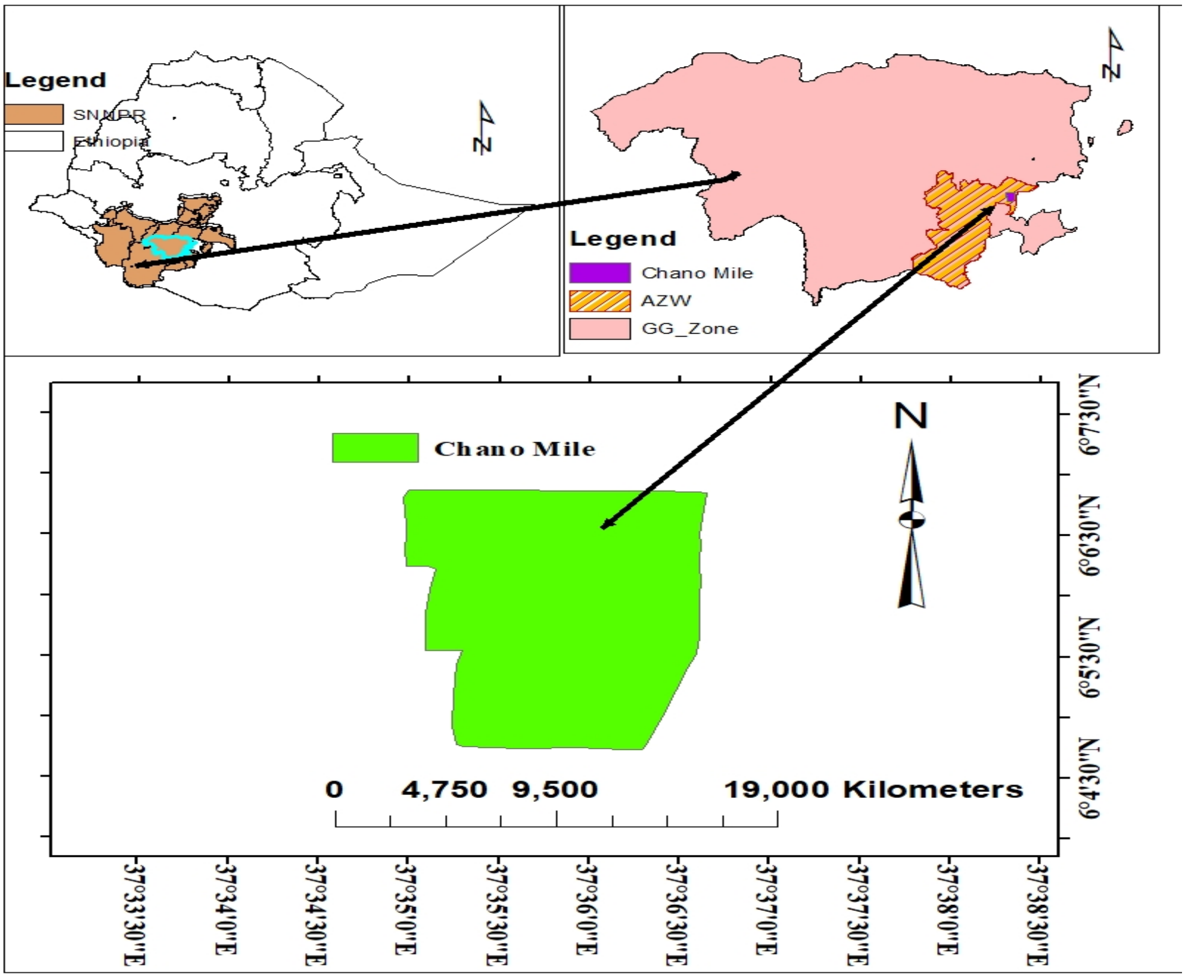

Table 1.Some soil physico-chemical characteristics of the study site

Soil parameters	Mean Values ± SD	Rating
pH	7.31±0.13	Neutral
Available Phosphorus (ppm)	21.9±8.66	Medium
Organic Carbon (%)	1.57±0.05	Medium
Total Nitrogen (%)	0.22±0.02	Medium
Bulk Density (gm/cm^3)	1.32±0.01	-
Particle Density (gm/cm^3)	2.15±0.16	-

SD= standard deviation

Plant Material and Nursery Management

Seeds of *M. oliefera* were collected from the Moringa park site of Arba Minch University. Seedlings for the trails were raised at the nursery site of Chano Mille, Arba MinchZuriyaworeda. Nursery sowing was done in July 2017 on seedbeds and after germination, the seedlings were pricked out into white polythene tubes with a diameter of 12cm and a length of 30cm. A shed was set up immediately after picking out to provide shade and

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was removed as necessary. While in the nursery the seedlings were watered twice per day during morning and evening hours except on days when it rained. This was, however, reduced for hardening to once every other day three weeks prior to planting.

Experimental Design and Management

The trail was planted using 60 days old seedlings in November 2017 on farmland that had previously been cropped with Cassava (Manihotesculenta). The field was plowed and leveled prior to planting. A completely randomized Block Design (RCBD) was used with four treatments (pollarding heights); 0.5m, 1.0m, 1.5m, 2.0m, and control (without pollarding) and replicated three times. Pollarding treatments were imposed after one year of planting (Fig 1). Square planting (1m x 1m) was employed on each plot (size of 25 m2), producing 25 seedlings per plot. Each block and plot was separated by a guard area of 3 and 2 m to avoid the influence on observations of trees from adjacent plots, respectively. During the course of the experimentation, weed management and watering at early age and cultivation were conducted. Pest and disease incidence was not observed during the experiment.

Fig 1. Pollarding activities conducted after 1 year of planting (A); and performance after one month of pollarding (B).

Data Collection

Six inner row plants were selected and marked for collection of all agronomic parameters from each plot. Data on fresh and dry leaf biomass was taken consecutively at 3, 6, 9, 12, 15 months after pollarding (i.e. at the age of 15, 18, 21, 24, 27 months respectively). The fresh and dry weight of leaves harvested per tree was determined using a weighing scale and beam balance respectively. The number of shoots rejuvenated after pollarding was counted and the length was measured by using measuring tape. The weight of fresh wood biomass which was cut after each leaf data collection was also measured.

Statistical Analysis

Statistical analysis of variance (ANOVA) of the data generated was done using the Genstat version 16.1 software. The differences between treatment means were determined using the protected Fisher's least significant difference (LSD) at a 5% probability level

Results and Discussion

Cutting height on shoot number and shoot height

Cutting height affected shoot number and height significantly ($P < 0.05$). A maximum number of shoots per tree was recorded with un-pollarded treatment (on control). The maximum shoot height per tree was recorded from the plants at 0.5-meter cutting height. For pollarding treatments, significant effects were not observed on fresh wood biomass harvested (Table 2)

Table 2: Effect of different cutting heights on number of shoots, the height of shoots, and fresh wood biomass of M. oleifera

Treatment	Number of shoots	Height of shoots(cm)	Fresh Wood Biomass (kg)
0.5m	7.0[b]	134 [a]	3.1[a]
1.0m	6.0[b]	100 [bc]	1.4[a]
1.5m	9.2[b]	112 [ab]	2.6[a]
2.0m	10.7[b]	95 [bc]	2.3[a]
Control	30.0[a]	79 [c]	2.2[a]
CV (%)	18.5	11.1	19.8
LSD	9.1	21.8	NS

Means showing different letters are significantly different in a column at a 5% probability level

Cutting Height on Fresh and Dry Leaf Biomass

Cutting height affected fresh and dry biomass of leaf significantly ($P < 0.05$). Maximum fresh leaf biomass (823g/tree) was recorded at 0.5-meter cutting height followed by 1.5 meters (729g/tree) and 2 meters (657g/tree). The lowest fresh leaf biomass was recorded with un-pollarded treatment (control) (268g/tree). Similarly, maximum and minimum dry leaf biomass was also obtained at 0.5-meter cutting height (222g/tree) and control (73g/tree) respectively (Table 2).The result of the present study was in line with Lazer (1981) who reported maximum yield of the shrubs occurred at shortcutting (20cm and 40cm above the ground), and Ezekieletal(2013) who reported a higher biomass yield of Moringaoliefera at lower (50 cm) pollarding height in Tanzania.

Table 3: Effect of different cutting heights on fresh and dry Leaf weight of *M. olifera*

Treatment	Fresh Leaf Biomass (g/tree)	Dry Leaf Biomass (g/tree)
0.5m	823 [a]	222[a]
1.0m	472 [c]	128[c]
1.5m	729 [b]	197[ab]
2.0m	657 [b]	178[b]
Control	268 [d]	73[d]
CV (%)	25.6	25.6
LSD	93	25.10

Means showing different letters are significantly different in a column at a 5% probability level

Conclusions and Recommendations

The results of the study showed that cutting height had a significant effect on the biomass growth and leaf yield of Moringaolifera. A pronounced effect was observed on leaf production as well as on re-growth after cutting. Thus, in the production of Moringa olifera as a source of leafy vegetable, it would require among other factors, the cutting height for multiple stem initiating is given due attention. Therefore, the present study concluded that the best cutting height for the study area to enhance the leaf biomass of Moringaolifera is 0.5meter above ground. Since the period of this study was short, further extended years investigation should be undertaken to obtain definitive recommendations on cutting height.

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