Studies on Biomass Yield of *Moringa Oleifera* as Influenced by Plant Density and Harvest Frequency and Adaptability and Horticultural Characterization of Different *Moringa* Accessions

BIOMASS YIELD OF *MORINGA OLEIFERA* AS INFLUENCED BY PLANT DENSITY AND HARVEST FREQUENCY

This study was conducted to determine the leaf biomass yield of *Moringa* as influenced by plant spacing (population density) and frequency of harvesting. From this study, minimum, optimum and maximum plant density and harvest frequency were established for leaf biomass production. The study also described the growth parameters of *Moringa* including plant height, number of side branches (shoots) and stem diameter as affected by plant density and harvest frequency.

The field experiment was conducted at CPU CARES Experimental Site in Leon, Iloilo for a period of 16 months (August 2013 to December 2014). Four plant spacing treatments and three pruning frequencies were evaluated in a factorial randomized block design with three replications. *Moringa* plants were grown at four plant densities: 1) 10,000; 2) 20,000; 3) 30,000, and 4) 40,000 plants per hectare. The plants were harvested at three frequency intervals: 4, 6 and 8 weeks.

Results showed that leaf biomass yield was influenced by both plant density and harvest frequency. There was also a significant interaction between plant density and harvest frequency.

Fresh leaf biomass increased as plant population increased from 10,000 to 40,000 pph. Similarly, the longer the harvest frequency the higher the leaf biomass. Thus, under this study and growing conditions, the minimum and maximum plant density for fresh leaf production would be 10,000 and 40,000 pph, respectively. The optimum plant density for fresh leaf production is between 20,000 and 30,000 pph. Although leaf production is low at 4-week harvest interval, this treatment may be desirable if there is a need for monthly supply of *Moringa* raw material for processing into leaf powder and other by-products. Harvest interval of 6 and 8 weeks may be too long for this purpose. The leaf-petiole ratio indicates that more leaves relative to petioles are developed at higher than lower plant density. Similar trend was observed in terms of dry leaf biomass production. There was also an increasing dry leaf biomass production with longer harvest frequency.

Plant density did not influence final plant height, but plant height was significantly influenced by harvest frequency. Plants harvested at 6-week interval were significantly taller that those harvested every 4 and 8 weeks. The data suggest that the more frequent the plants are harvested, the shorter will be the height.

The number of side shoots (branches) was not affected by plant density, but varied significantly due to the effect of harvest frequency. More side branches are developed when plants are frequently harvested (every four weeks). Frequent harvesting stimulates development of side shoots which will eventually result in high biomass yield.

There were no significant differences in stem diameter among plant population density. However, stem diameter varied significantly among harvest frequency. The mean stem diameter of plants harvested every 8 weeks was larger than those harvested every 4 and 6 weeks. This indicates that the longer interval between harvesting allows the plant to develop larger stem compared to plants with shorter pruning interval.

Conclusions

This study suggests that *Moringa* leaf biomass production is determined by plant population density and harvest frequency. Maximum plant density of 40,000 plants per hectare resulted in high leaf biomass yield, whereas longer harvest frequency (8-week interval) produced higher yield than shorter intervals. Plant growth parameters such as plant height, number of side shoots (branches) and stem diameter were more influenced by harvest frequency rather than by plant density.

Recommendations

Based on the findings and conclusion of the study, it is recommended that:

1. For maximum leaf biomass production, plant spacing of 0.5 x 0.5 m equivalent to plant population density of 40,000 per hectare should be used and/or adopted.

2. Further study and analysis should be conducted to determine leaf biomass production under plant density higher than 40,000 pph provided seed is available.

3. The influence of fertilizer level on biomass yield under various plant densities can be an important study for future investigation.

(***Source****:* Biomass Yield of *Moringa Oleifera* as Influenced by Plant Density and Harvest Frequency by Manuel C. Palada, Hope G. Patricio and Diaden E. Garcia (completed May 2015)

ADAPTABILITY AND HORTICULTURAL CHARACTERIZATION OF DIFFERENT MORINGA ACCESSIONS

Eighteen *Moringa* accessions from the AVRDC-The World Vegetable Center germplasm collections were evaluated in observational trials to determine the (1) percentage germination and survival of the *Moringa* accessions under CPU conditions, (2) their horticultural characteristics, (3) their susceptibility to insect pests and/or diseases, and (4) their coppicing capacity. The accessions originated from India (3), Laos (1), Taiwan (1), Tanzania (1), Thailand (10), and USA (1).

Seeds were first sown in small plastic pots with 2 kg of 1:1:1 soil, sand, compost mixture, grown inside the greenhouse for 9 weeks, then transferred outside in preparation for field transplanting. The seedlings were planted at 1.5-meter distance in non-replicated single rows spaced 2 meters apart.

Results revealed that seedlings started to emerge 6.3 to 10.6 days after sowing with Mo-34 from India having the earliest and Mo-40 also from India having the latest. Germination percentage ranged from 40 to 100% with eight accessions having 100% and two accessions having 40%. Survival ranged from 75 to 100%.

As to plant height, Mo-34 (India) emerged as the tallest with Mo-9 (Thailand) the shortest plants 6 weeks after planting (WAP). At 19 weeks after first pruning (WA1Pr), Mo-35 (Tanzania) was the tallest while Mo-15 (Thailand) 6 weeks after planting (WAP). At 19 weeks after first pruning (WA1Pr), Mo-35 (Tanzania) was the tallest while Mo-15 (Thailand) was the shortest. At 28 weeks after second pruning, Mo-2 (USA) and Mo-12 (Thailand) were the tallest and shortest, respectively. Mean stem diameter ranged from 3.5 cm (Mo-34) to 8.5 cm (Mo-4, Thailand). Mo-38 (Thailand) had the best coppicing capacity or the most branches (5.2) while Mo-33 (Philippines) had the poorest coppicing capacity or the least branches per plant. Mo-4 and Mo-14, both from Thailand, produced the highest leaf fresh weight exceeding 2 kg/plant from one pruning. Eight accessions yielded leaf fresh biomass exceeding kg/plant having yield potential of 3 to 7.8 t/ha of fresh leaf biomass. In terms of dry matter, Mo-6 (Thailand) and Mo-2 ranked first and second at 33.6% and 33.8%, respectively.

Among the 18 *Moringa oleifera* accessions, only 11 developed flowers which started to appear 49 to 93 days after transplanting (DAT). Of these 11 accessions, only 9 produced pods which started to appear 75 to 182 DAT. Mo-4 and Mo-20 (both from Thailand) did not produce any pod.

One year after planting, only seven accessions (Mo-2, Mo-3, Mo-7, Mo-29, Mo-34, Mo-35, and Mo-37 developed pods and seeds. Of these, Mo-3 produced the most pods per tree while Mo-34 produced the most seeds which can be explained by its longer pods which subsequently resulted in more seeds in spite of its lesser number of pods per tree.

Three years after planting, all the accessions with the exception of Mo-4 and Mo-6, developed flowers, pods, and seeds. Mo-38 produced the highest average number of seeds per pod while Mo-15 developed the most number of pods and seeds per tree.

Throughout the study, only red mites, coccinelid beetle, defoliator, leaf-footed bugs, and white flies were present but these caused only minor damage to the plants. Stem rot was the only pathogenic disease observed from a few plants.

Conclusions

This preliminary evaluation trial suggests that there are promising *Moringa* accessions adapted for local conditions with potential for high leaf biomass and seed production. Accessions from Thailand, India and USA possess desirable horticultural traits such as leaf fresh weight (Mo-4 and Mo-14), stem diameter (Mo-4, Mo-2 and Mo-40) and number of side branches (Mo-38, Mo-9 and Mo-40). Three accessions from Thailand (Mo-15, Mo-7 and Mo-9) and one from India (Mo-34) are ideal for seed production.

Recommendations

Based on the findings and conclusions of the study, it is recommended that: accessions with desirable leaf fresh weight (Mo-4 and Mo-14), dry matter weight (Mo-2 and Mo-6), stem diameter (Mo-4, Mo-2 and Mo-40), coppicing capacity (Mo-38, Mo-9 and Mo-40) and seed production (Mo-15, Mo-7, Mo-9 and Mo-34) should be propagated for commercial production; data on leaf yield and number of branches should be obtained at the same time to check if there is a significant positive correlation between these two parameters; the number of seeds/pod should be correlated with number of seeds/tree and the number of pods/tree with number of seeds/tree to determine in which accession is there a higher positive correlation between seed yield/tree and the two seed yield components; and, the results of this observational trial be validated using a replicated field trial when sufficient amount of seeds are available.

Source*:* Adaptability and Horticultural Characterization of Different *Moringa* Accessions Under Local Conditions (Study I-Observation Nursery) by Hope G. Patricio (completed August 2013)

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