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# Effect of harvesting cycles in biomass production of drumstick (*Moringa oleifera* Lam.)

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Moringa tree has been of great use not only to the human beings in terms of their health in one form or the other but also for their livestock as moringa makes nutritious fodder for cattles. Further, while the wood had the potential use in pulp industry, pods are used as vegetable and even the roots have potentially used in pharmacy apart from enriching the soil fertility when composted. The harvesting cycles had also effect on leaf biomass production. While, 4 months cycle had produced highest fresh leaf biomass (2810.00 g/plant) as well as dry leaf biomass (713.78 g/plant). Harvesting at 8months cycle had produced highest fresh wood biomass (9289.75 g/plant) followed by harvesting at 4 months cycle (5698.33 g/plant fresh wood). 8 month cycle had produced highest fresh pod biomass (4671.66 g/plant) as well as dry pod biomass (1957.20 g/plant). The 8 months cycle had produced highest total fresh biomass (13712.50 g/plant) as well as total dry biomass (8993.66 g/plant) compared to other cycles of harvesting. 8 months cycle had produced highest fresh root biomass (7452.50 g/plant) as well as dry root biomass (1686.20 g/plant).

**Key words :** Drumstick, Biomass, Leaf, Pod, Root, Wood

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## INTRODUCTION

*Moringa oleifera* Lam. Syn. *M. pteryogsperma* Gertin., belonging to a monogeneric family Moringaceae, is an important medicinal tree, commonly known as Shigru or Sahajan. All parts of the plant such as root, bark, leaf, gum and fruit have medicinal value and are used as drug for the treatment of several diseases and ailments. It is a under exploited perennial vegetable species of the Moringaceae family, native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. It has now become naturalized in many locations in the tropics. It is a perennial softwood tree with low timber quality but for centuries it has been advocated for traditional medicinal and industrial uses. The many uses of *Moringa* include: alley cropping (biomass production), bioenergy production, animal forage (leaves and treated seed-cake), biogas (from leaves), domestic cleaning agent (crushed leaves), blue dye (wood).

This tree has, in recent times, been advocated as an outstanding indigenous source of highly digestible protein, calcium, iron, vitamin C and carotenoids suitable for utilization in many of the "developing" regions of the world where, undernourishment is a major concern. *Moringa* trees have been used against malnutrition, especially among infants and nursing mothers. Six tablespoons of leaf powder is reported to provide nearly all of the woman's daily iron and calcium needs during pregnancy and breastfeeding (Martin, 1985). *Moringa* is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce. Presently, in India drumstick is being cultivated in an area of 38,000 ha with annual vegetable pod production of 1.10-1.30 million tonnes. Andhra Pradesh (15,665 ha) leads in area and production followed by Karnataka (10, 258 ha) and Tamil Nadu (7,408 ha) (Singh, 2011).

## RESEARCH METHODOLOGY

The experiment on effect of harvesting cycles in biomass production of drumstick (*Moringa oleifera*, Lam.) was conducted at the Research Field Unit, Department of Vegetable Science, College of Horticulture, Bagalkot (Karnataka) during 2012-13.

Bagalkot is located in Northern dry zone (KA-3) of Karnataka state at 16º 46' North latitude, 74º 59' East

longitudes and at an altitude of 533.0 m above the mean sea level. Bagalkot, which comes under Zone-3 of Region-2 among the agro climatic zone of Karnataka, has the benefit of both South-West and North-East monsoons. The average rainfall of South-West monsoon is 360 mm distributed over a period of four month (June to September) with an average 25 rainy days.

Randomized Black Design with four replications, each experimental plot consisted of 5 one year drumstick plants planted at a plant to plant spacing of 1.0 m in rows of 1.5m apart (6,666 plants/ha).

The basal pruning was done by heading back the plants leaving the main stems one feet above the ground level. After the basal pruning, the interculture was done and the recommended nutrients were given (Anonymous, 2007). The 5 plants were allocated for each treatment combination by using random table and replicated thrice. The above ground portion (fresh growth on the old main stem) was harvested at 2, 4, 6 and 8 months interval (cycles).

**Observation recorded :**

For recording observation on biomass production, 3 plants excluding two border plants were tagged and used for recording the observation after each harvesting (pruning) as per treatment. The pruned materials was separated as leaf, wood and pods and used for recording biomass yield.

The yield of all the cycles of pruning (2, 4, 6 and 8 months) was added and recorded as fresh leaf biomass per plant and expressed in grams. The 100 g leaf sample was oven dried to a constant weight to work out per cent dry matter content in the leaves and dry leaf biomass yield per plant per cent dry matter content in the leaf and expressed in terms of grams per plant.

The wood portion obtained in each cycle of the pruning from three plants in the treatments combination was weighed and added over all the cycles of harvests as per the treatments (2, 4, 6 and 8 months).The total weight over all the cycles of harvesting in a treatment was divided by three to obtain fresh wood yield per plant and expressed in grams. The dry biomass content of wood was computed by drying 100 g fresh wood to workout per cent dry matter content of wood. The dry biomass yield per plant was computed with the help of per cent dry matter content of wood and expressed in grams per plant.

The pod portion obtained at each cycle pruning (harvesting) from tagged plants was weighed and added over all the cycles of the harvesting and the average of three plants was recorded as fresh pod biomass per plant and expressed in grams. The dry matter per cent in pods were recorded by oven drying 100 g of fresh pod. The dry matter per cent of pod was used to compute the dry pod biomass yield and expressed in g per plant.

The fresh and dry biomass recorded separately for leaf, wood and pods were added and recorded as total biomass yield and expressed as g per plant.

After eight months (final cycle of harvesting) the tagged plants in each treatment were uprooted and the roots were separated and cleaned. The fresh root weight of each plant in a treatment was averaged and recorded as fresh root biomass yield and expressed in grams. The per cent dry matter content of root was worked out by drying 100 g root sample and the same was used to compute dry root biomass yield (g) per plant.

**Analysis of variance :**

The data collected from the experiment were subjected to statistical analysis of variance (ANOVA) by adopting Randomized Black Design. Interpretation of data was carried out as per the procedure given by Panse and Sukhatme (1967). The level of significance used in 'F' and't' test was P=0.05. Critical difference values were calculated whenever 'F' test was significant.

## RESEARCH FINDINGS AND ANALYSIS

Among the four harvesting cycles, $H_2$ (4 months interval) had produced significantly highest (2810.00 g/plant) fresh leaf biomass followed by $H_4$ (1468.33 g/plant) and $H_3$ (1373.33 g/ha). The least yield was in $H_1$ (1012.83 g/plant). Among the four harvesting cycles, $H_2$ (4 months interval) had produced significantly highest (713.78 g/plant) dry leaf biomass followed by $H_4$ (466.38 g/plant) and $H_3$ (370.31 g/plant). The least yield was in $H_1$ (244.25 g/plant) (Table 1). The harvesting cycles had also effect on leaf biomass production. While, 4 months cycle had produced highest fresh leaf biomass (2810.00 g/plant) as well as dry leaf biomass (713.78 g/plant). Thus, for higher biomass production 4 months cycle is better option than 2, 6 or 8 months cycles. Fidiyimu *et al.* (2011) reported higher biomass yield in closer intervals harvesting (6 weeks) than the 12 weeks cycle.

Among the three harvesting cycles (as in H1 no flowers and pods were produced) $H_4$ (8 months interval) had produced significantly highest (4671.66 g/plant) fresh pod biomass followed by $H_3$ (1176.66 g/plant) and the least yield was in $H_2$ (109.66 g/plant). Among the three harvesting cycles, $H_4$ (8 months interval) had produced significantly highest (391.77 g/plant) dry pod biomass followed by $H_3$ (206.36 g/plant) and the least yield was in $H_2$ (14.53 g/plant). The harvesting cycles had also significant effect on pod biomass production. While, 8 month cycle had produced highest fresh pod biomass (4671.66 g/plant) as well as dry pod biomass (391.77 g/plant) (Table 2). Hence, for higher pod biomass production 8 months cycle pruning was found better than 2 or 4 or 6 months cycle.

The 8months ($H_4$) cycle had recorded significantly highest (9289.75 g/plant) wood yield compared 2 months cycle

**Table 1: Effect of harvesting cycles on fresh and dry leaf biomass production in drumstick genotypes**

| | | Yield (g/plant) | | | |
|---|---|---|---|---|---|
| Sr. No. | Harvesting cycles | Fresh leaf | | Dry leaf | |
| 1. | $H_1$ (2 months) | 1012.83 | | 244.25 | |
| 2. | $H_2$ (4 months) | 2810.00 | | 713.78 | |
| 3. | $H_3$ (6 months) | 1373.33 | | 370.31 | |
| 4. | $H_4$ (8 months) | 1468.33 | | 466.38 | |
| | | C.D. (P=0.05) | SEm± | C.D. (P=0.05) | SEm± |
| | Factor H | 732.24 | 253.56 | 214.65 | 74.33 |

**Table 2: Effect of harvesting cycles on fresh and dry pod biomass production in drumstick genotypes**

| | | Yield (g/plant) | | | |
|---|---|---|---|---|---|
| Sr. No. | Harvesting cycles | Fresh leaf | | Dry leaf | |
| 1. | $H_2$ (4 months) | 109.66 | | 14.53 | |
| 2. | $H_3$ (6 months) | 1176.66 | | 206.36 | |
| 3. | $H_4$ (8 months) | 4671.66 | | 391.77 | |
| | | C.D. (P=0.05) | SEm± | C.D. (P=0.05) | SEm± |
| | Factor H | 1181.82 | 402.92 | 154.07 | 52.52 |

**Table 3: Effect of harvesting cycles on fresh and dry wood biomass production in drumstick genotypes**

| | | Yield (g/plant) | | | |
|---|---|---|---|---|---|
| Sr. No. | Harvesting cycles | Fresh leaf | | Dry leaf | |
| 1. | $H_1$ (2 months) | 1379.58 | | 238.57 | |
| 2. | $H_2$ (4 months) | 5698.33 | | 1095.63 | |
| 3. | $H_3$ (6 months) | 5287.50 | | 1091.47 | |
| 4. | $H_4$ (8 months) | 9289.75 | | 1957.20 | |
| | | C.D. (P=0.05) | SEm± | C.D. (P=0.05) | SEm± |
| | Factor H | 2210.01 | 765.28 | 483.84 | 167.54 |

**Table 4: Effect of harvesting cycles on total (leaf, wood and pod) fresh biomass yield of drumstick genotypes**

| | | Yield (g/plant) | | | |
|---|---|---|---|---|---|
| Sr. No. | Harvesting cycles | Fresh leaf | | Dry leaf | |
| 1. | $H_1$ (2 months) | 2225.58 | | 920.44 | |
| 2. | $H_2$ (4 months) | 8531.66 | | 3930.46 | |
| 3. | $H_3$ (6 months) | 7558.33 | | 4745.29 | |
| 4. | $H_4$ (8 months) | 13712.50 | | 8993.66 | |
| | | C.D. (P=0.05) | SEm± | C.D. (P=0.05) | SEm± |
| | Factor H | 3736.65 | 1293.9 | 2189.10 | 758.04 |

**Table 5: : Effect of harvesting cycles on fresh and dry root biomass production in drumstick genotypes**

| | | Yield (g/plant) | | | |
|---|---|---|---|---|---|
| Sr. No. | Harvesting cycles | Fresh leaf | | Dry leaf | |
| 1. | $H_1$ (2 months) | 1577.50 | | 276.92 | |
| 2. | $H_2$ (4 months) | 2281.66 | | 430.03 | |
| 3. | $H_3$ (6 months) | 3611.66 | | 783.45 | |
| 4. | $H_4$ (8 months) | 7452.50 | | 1686.20 | |
| | | C.D. (P=0.05) | SEm± | C.D. (P=0.05) | SEm± |
| | Factor H | 926.84 | 320.95 | 280.05 | 96.97 |

(1379.58 g/plant). The $H_2$ (5698.33 g/plant) and $H_3$ (5287.50 g/plant) were at the par with respect to wood yield. The 8 months ($H_4$) cycle had recorded significantly highest (1957.20 g/plant) wood yield compared 2 months cycle (238.57 g/plant). The $H_2$ (1095.63 g/plant) and $H_3$ (1091.47 g/plant) were at the par with respect to wood yield. The harvesting cycles had also exerted significant effect on wood biomass production. Harvesting at 8months cycle had produced highest fresh wood biomass (1957.20 g/plant) followed by harvesting at 4months cycle (1095.63 g/plant dry wood) (Table 3). Hence, for higher biomass production 8 months cycle is the best option than 2 or 4 or 6 months cycles. Higher biomass yield in long durational harvesting cycles were also reported by Amaglo *et al.* (2006) and Fadiyimu *et al.* (2011).

The harvesting cycle also significantly influenced the total dry biomass production in drumstick genotypes. Harvesting at 8 months cycle ($H_4$) had recorded significantly highest total dry biomass (8993.66 g/plant) compared to all other three cycles of harvesting. The total biomass was least in 2 months cycle (920.44 g/plant). The yield of $H_3$ (4745.29 g/plant) and $H_2$ (3930.46 g/plant) did not differ significantly. The harvesting cycles also significantly influenced the total fresh biomass production in drumstick genotypes. Harvesting at 8 months cycle ($H_4$) had recorded significantly highest total biomass (13712.50 g/plant) compared to all other three cycles of harvesting. The total biomass was least in 2 month cycle (2225.58 g/plant). The yield of $H_2$ (8531.66 g/plant) and $H_3$ (7558.33 g/plant) did not differ significantly. The harvesting cycles had also effect on total biomass production. The 8 months cycle had produced highest total fresh biomass (13712.50 g/plant) as well as total dry biomass (8993.66 g/plant) compared to other cycles of harvesting (Table 4). Hence, for getting higher total biomass production 8 months cycle was found to be better option than 2 or 4 or 6 months cycles.

The harvesting cycles had also significantly influenced the fresh root yield. The yield was significantly highest (7452.50 g/plant) in $H_4$ cycle and was least in $H_1$ (1577.50 g/plant). The harvesting cycles had also excreted effect on dry root biomass production. While, 8 months cycle had produced highest fresh root biomass (7452.50 g/plant) as well as dry root biomass (1686.20 g/plant), the least dry root biomass was recorded in 2 months cycle (276.92 g/plant) (Table 5). It seems, frequent harvesting of tops of the drumstick plants had affected the sufficient and continuous flow of metabolites to the development of roots. Hence, there was proportionate decrease (1686.20 g/plant and 276.92 g/plant) in the root dry matter production when frequency of pruning was reduced from 8 months cycle to 2 months cycle. Goss (2012) reported robust rooting in drumstick plants in high density planting compared to low plant population.

**Conclusion :**

The harvesting cycles at 4 months interval was found optimum for getting high leaf biomass (fresh and dry), for higher wood biomass, pod biomass, root biomass and total top portion biomass, harvesting once at 8 months interval was found optimum. Thus, if the drumstick crop is intended for leafy vegetable and forage purpose pruning at 4 months cycle could be adopted and if the crop is intended for pod, fuel, wood (pulp) or root purpose, pruning at 8 months interval has been advocated.

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