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Dynamics of fresh and dry biomass production in drumstick (*Moringa oleifera* Lam.) genotypes

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A study was carried out at College of Horticulture, Bagalkot, Karnataka to know the dynamics of fresh and dry biomass production in drumstick genotypes during the year 2012-13. The experiment consisted of four genotypes *viz.*, MS/SP-11, MS/LP-11, KDM-01 and S-6/4 laid out in Randomized Block Design with six replications. Result revealed that the, biomass production potentiality of the drumstick genotypes highest fresh and dry leaf biomass (2033.08 g/plant and 549.78 g/plant, respectively) was recorded in MS/SP-11. Also the same genotype MS/SP-11 was produced highest fresh and dry wood biomass (5943.33 g/plant and 1264.54g /plant, respectively). Whereas, genotype MS/LP-11 produced highest fresh pod (4652.44 g/plant) and dry pod (370.08 g/plant) biomass. Also the same genotype MS/LP-11 produced highest fresh and dry total biomass production (9759.16 g/plant and 5704.19 g/plant, respectively). Whereas, genotype MS/LP-11 produced highest fresh and dry root biomass production (4700.83 g/plant and 1143.53 g/plant, respectively).

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

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INTRODUCTION

Drumstick (*Moringa oleifera* Lam.) is the under exploited perennial vegetable species of the Moringaceae family, native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree is also known as the horseradish tree, drumstick tree, benzolive tree. It is already an important crop in India, Ethiopia, the Philippines and the Sudan and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands as all parts of the moringa tree are edible and have long been consumed by humans. 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), fencing (living trees), fertilizer (seed-cake), foliar nutrient (juice extracted from the leaves), green manure (from leaves), gum (from tree trunks), sugar cane juice-clarifier (powdered seeds), honey (flower nectar), medicine (all plant parts), ornamental plantings, biopesticide (soil incorporation of leaves to prevent seedling damping off), pulp (wood), rope (bark), tanning hides (bark and gum) and water purification (powdered seeds). Moringa seed oil (yield 30-40% by weight) is also known as Ben oil. 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). Though almost all the parts of the plants have potential uses either as nutritive food, fodder or energy (biomass) or medicine, its present commercial cultivation is limited to vegetable pod production. The studies related to biomass production are scanty. Therefore, the present study was carried out to know the dynamics of biomass production in drumstick genotypes.

RESEARCH METHODOLOGY

The experiment on dynamics of fresh and dry biomass production in drumstick genotypes (*Moringa oleifera*) was conducted at the Research Field Unit, Department of Vegetable Science, College of Horticulture, Bagalkot (Karnataka) during 2012-13. The experiment was laid out in a Randomized Block Design with six replications.

Bagalkot is located in Northern dry zone (under zone -3 of region -2) of Karnataka state at 16º 46× North latitude,

Table A : Meteorological data recorded for the experimental period from January (2012) to March (2013) in Agricultural Research Station, Bagalkot

Month	Temperature (^{0}c)		Rainfall (mm)	Humidity (%)	
	Minimum	Maximum		Morning	Evening
January 2012	14.65	29.91	0	74.10	26.94
February 2012	16.58	33.10	0	58.69	20.10
March 2012	18.84	36.01	0	63.52	14.65
April 2012	23.48	36.63	26.0	73.9	22.73
May 2012	23.75	36.27	32.5	77.65	25.23
June 2012	23.16	32.61	33.5	83.73	42.40
July 2012	22.77	30.36	49.0	90.65	56.87
August 2012	22.18	30.03	51.5	97.68	71.13
September 2012	21.37	30.53	63.0	97.03	69.63
October 2012	20.14	30.04	71.50	87.93	56.80
November 2012	18.11	28.99	76.50	88.45	53.90
December 2012	16.24	29.88	0	76.70	38.06
January 2013	18.77	31.6	0	86.6	52.20
February 2013	18.64	32.58	7.5	82.33	48.55
March 2013	21.10	35.26	19.5	52.33	21.66

74 º 59' East longitudes and at an altitude of 533.0 m above the mean sea level and. 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. The average rainfall of North-East monsoon is about 136 mm with an average 8 rainy days. During the experimental period, the meteorological data recorded at meteorological observatory of the Agricultural Research Station, Bagalkot is presented in Table A.

One year old drumstick plantations of 4 genotypes *viz.*, MS/SP-11, MS/LP-11, KDM-01 and S-6/4 were used for the studies. 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 intercultural operation was done and the recommended nutrients were provided to the plants (Anonymous, 2007). 5 plants were allocated for each treatment combination by using random table and replicated six times.

The leaf weight of each plant after harvesting was weighed and recorded in grams, 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, the wood portion obtained in the pruning from three plants in the treatments combination was weighed. The total weight 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 pod portion obtained at from tagged plants was weighed and the average of three plants was recorded as fresh pod biomass per plant and expressed in grams, the dry matter per cent in pod was recorded by oven drying 100 g of fresh pod and 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 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.

The data collected from the experiment were subjected to statistical analysis of variance (ANOVA) by adopting Randomized Block 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

The drumstick genotypes differed significantly with respect to fresh and dry leaf biomass production. Significantly highest fresh biomass (2033.08 g/plant) was recorded in MS/SP-11, while S-6/4 had produced least (1490.83 g/plant) biomass. The highest dry biomass (549.78 g/plant) was recorded in MS/SP-11 while, KDM-01 had produced least (382.36 g/plant) biomass (Table 1). The biomass production is the product of inherent genetic makeup of genotypes and environment under which genotypes were cultivated. Superiority of MS/SP-11 may be attributed to its genetic makeup and its suitability to the environmental condition in which the experiment were conducted. Therefore, the genotype G_1 which is superior in terms of leaf biomass

Table 1 : Fresh and dry leaf biomass production in drumstick genotypes

Drumstick genotypes	Leaf biomass yield (g/plant)	
	Fresh	Dry
MS/SP-11	2033.08	549.78
MS/LP-11	1586.00	431.02
KDM-01	1554.58	382.36
S-6/4	1490.83	431.56
SEm±	253.56	74.33
C.D. (P=0.05)	732.24	214.65

Table 2 : Fresh and dry wood biomass production in drumstick genotypes

Drumstick genotypes	Wood biomass yield (g/plant)	
	Fresh	Dry
MS/SP-11	5943.33	1264.54
MS/LP-11	6143.33	1221.38
KDM-01	4811.25	994.85
S-6/4	4757.25	902.11
SEm ±	765.28	167.54
C.D. (P=0.05)	NS	483.84

Table 3 : Fresh and dry pod biomass production in drumstick genotypes

Drumstick genotypes	Pod biomass yield (g/plant)	
	Fresh	Dry
MS/SP-11	1074.55	150.15
MS/LP-11	4652.44	370.08
KDM-01	1655.88	214.97
S-6/4	561.11	81.67
SEm ±	465.26	60.65
C.D. (P=0.05)	1364.65	177.90

Table 4 : Total (leaf, wood and pod) fresh and dry biomass yield of drumstick genotypes

Drumstick genotypes	Total biomass yield (g/plant)	
	Fresh	Dry
MS/SP-11	8913.33	5205.71
MS/LP-11	9759.16	5704.19
KDM-01	7479.25	3906.22
S-6/4	5876.33	3773.71
SEm±	1293.9	758.04
C.D. (P=0.05)	3736.65	2189.10

Table 5 : Fresh and dry root biomass production in drumstick genotypes

Drumstick genotypes	Root biomass yield (g/plant)	
	Fresh	Dry
MS/SP-11	3416.66	754.43
MS/LP-11	4700.83	1143.53
KDM-01	3265.00	577.88
S-6/4	3540.83	700.75
SEm ±	320.95	96.97
C.D. (P=0.05)	926.84	280.05

production has the potentiality for exploitation for meeting the nutrition requirement by way of large scale cultivation or by popularizing the genotype in home/school gardens. Apart from this higher leaf biomass had also opened the opportunity for its utilization as good source of nutritious cattle feed (Nadir *et al.*, 2006) and good source of raw materials for bio energy/ bio gas production.

The fresh wood yield per hectare significantly varied with drumstick genotypes. While, the genotype MS /SP-11 was significantly superior (5943.33 g/plant) over S-6/4 (4757.25 g/plant) and it was at par with MS/LP-11 and KDM-01. And also dry wood yield per hectare was in the genotype MS /SP-11 was significantly superior (1264.54 g/plant) over S-6/4 (902.11 g/plant) and it was at par with G_2 and G_3 (Table 2). The superiority of the genotype may be attributed to its inherent genetic makeup. Though, the wood of drumstick has low timber value, it has greater utility in paper and pulp industry and as fuel or could be composted as valuable organic manure. Hence, the genotypes MS/SP-11 (1264.54 g/plant), followed by MS/LP-11 (1221.38 g/plant dry wood) have the potential for exploiting them in paper or pulp industry (Goss, 2012).

The drumstick genotypes differed significantly with respect to pod biomass production. Significantly highest fresh pod biomass was recorded in MS/LP-11 (4652.44 g/plant) and while, S-6/4 had produced least (561.11 g/plant) biomass and also highest dry pod biomass (370.08 g/plant) was recorded in MS/LP-11 while, S-6/4 had produced least (81.67 g/plant) biomass (Table 3). Superiority of MS/LP-11 may be attributed to its genetic makeup and suitability to the environmental condition in which the genotypes were tested. The genotypes with higher pod biomass production capacity could be of much use for exploitation of production either as fresh vegetable pods or for converting the pods in to powder form to use them for enrichment of nutrition common food products. Priyanka and Shashi (2011) also reported that the products developed from drumstick pod powder were rich in energy and micronutrient and could be easily prepared at household level and adopted for small scale entrepreneurship to generate income.

The drumstick genotypes differed significantly with respect to total fresh biomass production (above ground portion) per hectare. The genotype MS /LP-11 was significantly superior in total biomass production (9759.16 g/plant) compared to S-6/4 (5876.33 g/plant). The genotype MS /LP-11 was significantly superior in total dry biomass production (5704.19 g/plant) compared to S-6/4(3773.71 g/plant) (Table 4). However, MS/SP-11 was at par with other two genotypes. The total biomass production is the product of inherent genetic makeup of genotypes and environment under which genotypes were cultivated. Superiority of MS/LP-11 may also be attributed to its superiority in leaf, pod and wood biomass production.

The drumstick genotypes differed significantly with respect to the fresh root biomass yield. Genotype MS/LP-11 had recorded significantly highest fresh root yield (4700.83 g/ plant) compared to all other genotypes, the root yield was least in KDM-01 (3265.00 g/plant). The MS/LP-11 had recorded significantly highest dry root yield (1143.53 g/plant) compared to all other genotypes, the dry root yield was least in KDM-01 (577.88 g/plant) (Table 5). The superiority of the MS/LP-11 may be attributed to its genetic makeup. The next best genotype was MS/SP-11 (754.43 g/plant dry root biomass). These two genotypes which have high potential of root biomass production could be used for root production which has utility in pharmacy apart from enrichment of soil fertility when the roots were decomposed *in situ* or composted by uprooting.

Conclusion :

The results of biomass production potentiality of the drumstick genotypes reveal that among the four genotypes tested, the genotype MS/LP-11, followed by MS/SP-11 were superior as to their leaf, wood, pod, root and total either fresh or dry biomass production potential compared to the two released and commercially cultivated genotypes KDM-01 and S/6/4.

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