

Study on Effects of Fertilizer on Production Performance of *Moringa Oleifera* (*Moringa Oleifera* Lam.) In Autumn Season

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Abstract – *Moringa oleifera* is one of the world's most nutrient rich, fast growing tree possibly cultivate as fodder by establishing agronomical practices to mitigate high nutrient demand. The study was conducted to know the effect of different fertilizer doses on production performance of *Moringa oleifera* as fodder in autumn. A land size of 20×12 m² with a plant density of 13,500/hectare, was equally divided into 18 sub-plots. Keeping randomly 6 of them as a control (F₀), the rest 12 sub-plots were randomly grouped into two; one of them of 6 plots was fertilized with N:P:K at a ratio of 90:30:15, respectively considered as F₁ treatment group; and the other 6 plots with a ratio of 160:60:40, respectively considered as F₂ treatment group. The experimental design was arranged in Completely Randomized Design (CRD). The BM, DM and CP yield were significantly (P<0.001) higher in 1st cutting than that of 2nd cutting. The BM & DM yield obtained with different treatment groups did not vary significantly (p>0.05) in both first and overall cutting. But in case of 2nd cutting, the average BM and DM yield were significantly (P<0.05) higher in control fertilizer doses (F₀) than F₁ and F₂ fertilizer doses, whereas the CP yield obtained with different treatments differed significantly (P<0.05) in both first & second cutting and did not differ significantly (p>0.05) in overall cutting. In case of 1st cutting, the increased CP yield was observed in F₁ fertilizer doses and in case of 2nd cutting, the CP yield increased in F₀ than other fertilizer doses. It could be concluded that medium doses of fertilizer is suitable for optimum production of *Moringa oleifera* during autumn in its decreasing temperature and humidity.

Keywords – Biomass Production, Fertilizer, Fodder, Season.

I. INTRODUCTION

Livestock plays an important role in most small-scale farming systems throughout the world but inadequate livestock nutrition is a common problem in the developing world. Nowadays the most burning issue is food and feed security for human and animal. In the sense of this perspective any productive component like *Moringa oleifera* as a fodder is very important tools to ensure the food and feed security. *Moringa oleifera* is a farmer friendly and useful plant from top to bottom as it uses as traditional medicine for human health [1, 2, 3], plant growth enhancer [4], water purification agent [5, 6], natural oil [7], potential source of biodiesel [8] and most importantly as livestock feed and fodder. *Moringa* (*M.*

oleifera) is rich in such type of nutrients, which are essential for livestock for weight gain (up to 32%) and increase in milk production (up to 43-65%) [9]. Feeding *Moringa* leaves to livestock results in both weight gain and improved nutritional status [10, 11, 12, 13]. For the betterment of livestock and availability of feeds through establishing methods of *Moringa* fodder cultivation, introduce it as a common fodder to farmer and familiar farmers with it as a highly nutritious & cost effective fodder could be a revolutionary work. Implemented works in abroad relevant with, determined the best suited season for the production of *moringa* is July-October [14]. In southern India the seeds are sowed in September and the limb cuttings are planted in June-August to facilitate easy rooting and further growth with monsoon rains [15]. Flowering occur once a year (April-June) in seasonal cool region and twice or even all year round with constant rainfall and seasonal temperature [16]. Ideal soil pH range for optimum production of *Moringa* is 5.5-7.0, as though it can be grown in most types of soil from acid to alkaline [17]. It grows best in dry sandy soil and tolerates drought, poor soil including coastal areas but in cool temperature with wet condition it do not grow well. At an elevation of up to 1000m above sea level it grows naturally [18, 19]. It grows well without addition of fertilizer but, usually to get better production manures and fertilizers are applied [20, 21]. Once established, *moringa* rarely need watering. It favors rainwater for grown well without irrigation [21, 18]. Either by direct seeding, transplanting, or using hard stem cuttings *Moringa* could be planted [21]. *Moringa* is often cultivated annually to serve commercial purpose but usually grown as perennial [22]. Season as well as weather, variety, fertilization and irrigation regime affects the yields vary widely. Best yield can be get under dry and warm condition if some supplemental fertilizer and irrigation is applied [23]. But the fact is, accords perspective weather of Bangladesh cultivating pattern is not established, even seasonal weather response on biomass production is unknown and the standard dose of fertilizer application for the optimum production of *M. oleifera* as fodder is presently undetermined yet. Therefore, this study was undertaken; only goal to know the impact of autumn season on biomass production of *Moringa oleifera* whether this season is suitable for cultivation or not and to determine

the standard doses of fertilizer for optimum production of *Moringa oleifera* in autumn season.

II. METHODOLOGY

The study was conducted during September-November, 2013 (Autumn) in Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh, located in middle of the Young Brahmaputra and Jamuna flood plain & Madhupur Tract of agro-ecological zone having gray flood plain & Madhupur Tract soil. A land size of 20×12 m² with a plant density of 13,500/hectare, was equally divided into 18 sub-plots. The soil was slightly acidic in reaction (pH 5.6-6.5) silt loam texture. The land was flat, moderate drained and above flood levels. The present reading of different parameters of weather were listed down regularly from the research site and the chemical analysis and *in-sacco* organic matter digestibility of the *M. oleifera* samples were done at the Animal Nutrition Laboratory of BLRI. The response against different fertilizer doses on biomass production of *Moringa Oleifera* were studied following Completely Randomized Design (CRD) with three treatments control (F₀), medium (F₁) and high (F₂) chemical fertilization comprising six replications in each treatment. Except control (without chemical fertilization), the medium and high treatment groups were fertilized with N:P:K at a ratio of 90:30:15 and 160:60:40, respectively. Half of the total amount of all fertilizer was applied into soil after earthen up as basal doses. The remaining amount of fertilizers both medium and high was applied into soil during foliage growth after weeding. No extra irrigation was used due to optimum rainfall and excess water during heavy rain was drained out but moisture in the soil was at desired level. Data on daily temperature, humidity, rainfall and day-length were recorded regularly from the site. Fertilization, other agronomic practices and sample collection procedure were same in consecutive two cuttings and foliage in each unit plot was harvested and biomass yield was recorded at 33 and 31 days of growth during 1st and 2nd cutting, respectively. The green forage was harvested from the beneath of each stem where the shoots were grown. The total harvesting was done in a single day and biomass yield (BM) recorded accordingly. The sample was collected from each plot and brought to laboratory for its nutritional analysis. Collected samples of *M. oleifera* of different treatments were analyzed for determination of dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), ether extract (EE) and ash according to AOAC (1990). Compositated sample

of each treatment weighing 4 gm, grinding through a 3.55 mm screen was studied following “Nylon-bag digestibility” technique for determination of *In-sacco* digestibility of *M. oleifera* up to 48 hours. Responses of different treatments were compared statistically in an ANOVA of a Completely Randomized Design (CRD) using SPSS 11.5 computer software.

III. RESULTS AND DISCUSSION

Impact of Season on Biomass Yield

If the objective is production of green fodder with a maximum of protein and a minimum of lignin content, then harvesting should be done every 33 to 40 days [21]. After the first cutting, 5 days later, the re-growth was observed. Following this experimental approach, at least 10 harvests per year are obtainable. Whereas [21] and [25] suggested approaches by which six harvests/year and nine harvests/year, respectively are obtainable.

Irrespective of treatment effects, the overall total biomass (BM) and DM yield per hectare of *M. oleifera* during first and second cutting was 2604.82, 465.01kg and 1387.85, 239.70 kg, respectively (Table 1). In spite of lower production in second cutting; the total biomass production and DM yield during whole autumn season was 3,992.67 kg (3.99 ton/ha) and 704.71 kg/ha (0.7 ton/ha). The average temperature and humidity during 1st and 2nd cutting were 27 °C and 81 % and 24 °C and 60 %, respectively. During first cutting, the ambient temperature and humidity was 5-7°C and 19-22%, respectively higher than temperature and humidity obtained during second cutting. Rainfall was totally stopped during the time of second cutting. The decreased temperature & humidity and zero precipitation in second cutting might be the causes of lower production of *Moringa Oleifera* compare to first cutting.

Effect of Fertilizer Doses on Yields of Moringa Oleifera

In first cutting, the BM and DM yield did not vary significantly ($p>0.05$) among the fertilizer treatment groups. Though, statistically not significant, but the higher BM and DM yield was obtained in F₁ treatment group followed by F₂ and F₀ groups. However, the CP yield increased significantly ($p<0.05$) in F₁ treatment group compare to that of F₀ and F₂ treatment groups. In second cutting, the BM, DM and CP yield differ significantly ($p<0.05$) among the different treatment groups. The BM, DM and CP yield were significantly ($p<0.05$) higher in F₀ treatment group followed by F₁ and F₂ treatment groups.

Table 1. Effect of fertilizer doses on yields of *Moringa Oleifera* in different cuts

Parameters	Mean (± SE) for different treatment groups			Overall	Level of Significance
	F ₀	F ₁	F ₂		
1st Cutting					
Biomass yield (kg/ha)	2175.54±244.24	3050.76±191.42	2588.15±415.77	2604.82±184.14	NS
DM yield (kg/ha)	381.25±46.87	551.27±33.13	462.51±77.72	465.01±34.62	NS
CP yield (kg/ha)	67.42 ^b ±8.62	116.84 ^a ±7.80	83.04 ^b ±13.54	89.10±7.50	*
2nd Cutting					
Biomass yield	1737.93 ^a ±144.19	1462.87 ^{ab} ±189.54	962.74 ^b ±207.19	1387.85±125.80	*

(kg/ha)					
DM yield (kg/ha)	299.55 ^a ±21.89	253.16 ^{ab} ±32.87	166.37 ^b ±36.57	239.70±21.52	*
CP yield (kg/ha)	67.04 ^a ±5.30	52.92 ^{ab} ±6.67	35.94 ^b ±8.23	51.97±4.82	*
Overall					
Biomass yield (kg/ha)	1956.74±150.45	2256.81±271.66	1775.44±330.29	1996.33 ±150.52	NS
DM yield (kg/ha)	340.40±27.56	402.21±50.15	314.44±60.58	352.35 ±27.68	NS
CP yield (kg/ha)	67.23±4.83	84.88±10.81	59.49±10.37	70.53 ±5.40	NS

Significant level=(Non Significant= $P>0.05$; *= $P<0.05$, significantly different; ^{ab} values with different superscripts in the same row differ significantly; SE: Standard error of mean and treatment F₀ (Without fertilizer), F₁ (Medium fertilizer), F₂ (High fertilizer); DM= dry matter, OM= organic matter, CP= crude protein.

In first cutting, the BM and DM yield did not vary significantly ($p>0.05$) among the fertilizer treatment groups. Though, statistically not significant, but the higher BM and DM yield was obtained in F₁ treatment group followed by F₂ and F₀ groups. However, the CP yield increased significantly ($p<0.05$) in F₁ treatment group compare to that of F₀ and F₂ treatment groups. In second cutting, the BM, DM and CP yield differ significantly ($p<0.05$) among the different treatment groups. The BM, DM and CP yield were significantly ($p<0.05$) higher in F₀ treatment group followed by F₁ and F₂ treatment groups (Table 1). The decreased ambient temperature and humidity during the second cutting might be the reasons for lower BM, DM and CP yield as compare to first cutting. Irrespective of cutting, the overall BM, DM and CP yield were relatively higher in F₁ treatment group compare to F₀ and F₂ treatment groups and the differences among the treatment groups were non-significant ($p>0.05$). Usually, to get better production manures and fertilizers are applied. But, without fertilizer moringa trees are able to grow successfully [24]. Even, once established, the deep and far-reaching root system of moringa can gather it's nutrients from the soil efficiently [21]. [26] in

their study observed a positive response from moringa through application of manures and fertilizers.

Effect of Fertilizer on Chemical Composition

The fertilizer effects on chemical composition of *M. oleifera* are presented in Table 2. The DM content of *M. oleifera* in first, second and overall cutting was non-significant ($p>0.05$) among the treatment groups. But F₁ treatment group had relatively higher ($p>0.05$) DM content for both the first, second and overall cutting. In first cutting, the OM ($p<0.05$) and CP ($p<0.01$) content of *M. oleifera* was significantly higher in F₁ treatment group than F₀ and F₂ treatment groups. In second cutting, the OM content did not vary significantly ($p>0.05$) but significantly ($p<0.05$) higher CP content was obtained in F₀ treatment group compared to F₁ and F₂ treatment groups. Irrespective of cutting, the overall DM ($p>0.05$), OM ($p<0.05$) and CP ($p>0.05$) content of *M. oleifera* was higher in F₁ treatment group as compared to that of F₀ and F₂ treatment groups (Table 2). [27] reported a higher DM (25.5%) and lower OM content (88.4%) in fresh biomass of *M. oleifera*.

Table 2. Effect of fertilizer doses on DM, CP, OM and Ash (%) of *M. oleifera* in 1st, 2nd and overall cutting

Parameters	Mean (± SE) for different treatment groups				Level of Significance
	F ₀	F ₁	F ₂	Overall	
1st Cutting					
DM (%)	17.45±0.36	18.08±0.06	17.72±0.22	17.75±0.15	NS
OM (% on DM)	92.73 ^{ab} ±0.17	93.11 ^a ±0.11	92.50 ^b ±0.13	92.78±0.10	*
CP (%)	17.65 ^b ±0.22	21.16 ^a ±0.25	18.06 ^b ±0.20	18.96±0.40	**
Ash (%)	7.38 ^{ab} ±0.17	7.14 ^a ±0.11	7.70 ^b ±0.13	7.41±0.09	*
2nd Cutting					
DM (%)	17.31±0.26	17.34±0.50	17.25±0.42	17.30±0.22	NS
OM (% on DM)	92.73±0.40	93.11±0.08	92.50±0.16	92.78±0.15	NS
CP (%)	22.33 ^a ±0.28	20.94 ^b ±0.13	21.41 ^b ±0.22	21.56±0.18	*
Ash (%)	7.27±0.40	6.89±0.09	7.50±0.16	7.22±0.15	NS
Overall					
DM (%)	17.38±0.21	17.71±0.26	17.49±0.24	17.53±0.14	NS
OM (% on DM)	92.67 ^{ab} ±0.71	92.98 ^a ±0.27	92.40 ^b ±0.36	92.69±0.53	*
CP (%)	19.99±0.73	21.05±0.14	19.73±0.53	20.26±0.31	NS
Ash (%)	7.33 ^{ab} ±0.21	7.02 ^a ±0.08	7.60 ^b ±0.10	7.31±0.09	*

Significant level=(Non Significant= $P>0.05$; *= $P<0.05$, significantly different; **= $P<0.01$, highly significant), ^{ab} values with different superscripts in the same row differ significantly; SE: Standard error of mean and treatment F₀ (Without fertilizer), F₁ (Medium fertilizer), F₂ (High fertilizer); DM= dry matter, OM= organic matter, CP= crude protein.

ADF & NDF content (g/100g) of *M. oleifera* in response to F₀, F₁ and F₂ treatments in first and second cutting were 26.44, 27.13, 21.82 & 23.15, 21.14, 21.64 and 57.07,

53.63, 53.51 & 43.80, 38.80, 32.17 (Table 3), respectively. In first cutting ADF and in second cutting NDF was obtained significantly ($p<0.01$) lower percentage,

respectively with high doses of fertilizer (F_2), than all other treatments. Irrespective of cutting, the overall ADF & NDF content was non-significant ($p>0.05$) among the different treatment groups. The EE content of *M. oleifera*

was relatively higher in F_0 treatment group for both the first ($p>0.05$), second ($p<0.01$) and overall cutting ($p>0.05$) compared to that of F_1 and F_2 treatment groups (Table 3).

Table 3. Effect of fertilizer on ADF, NDF and EE

Parameters	Mean (\pm SE) for different treatment groups				Level of Significance
	F_0	F_1	F_2	overall	
1st Cutting					
ADF	26.44 ^b \pm 0.39	27.13 ^b \pm 0.48	21.82 ^a \pm 0.38	25.13 \pm 0.86	**
NDF	57.07 \pm 1.10	53.63 \pm 1.16	53.51 \pm 0.65	54.74 \pm 0.77	NS
EE	3.73 \pm 0.07	3.52 \pm 0.27	3.65 \pm 0.10	3.63 \pm 0.09	NS
2nd Cutting					
ADF	23.15 \pm 1.28	21.14 \pm 1.81	21.64 \pm 0.77	21.98 \pm 0.74	NS
NDF	43.80 ^b \pm 0.99	38.80 ^b \pm 1.94	32.17 ^a \pm 1.87	38.26 \pm 1.88	*
EE	3.05 ^a \pm 0.04	2.97 ^a \pm 0.03	2.66 ^b \pm 0.03	2.89 \pm 0.06	**
Overall					
ADF	24.80 \pm 0.95	24.14 \pm 1.58	21.73 \pm 0.38	23.56 \pm 0.67	NS
NDF	50.43 \pm 3.04	46.22 \pm 3.47	42.84 \pm 4.85	46.50 \pm 2.23	NS
EE	3.39 \pm 0.15	3.25 \pm 0.17	3.15 \pm 0.23	3.26 \pm 0.10	NS

Significant level= (Non Significant= $p>0.05$; *= $p<0.05$, significantly different; **= $p<0.01$, highly significant), ^{ab} values with different superscripts in the same row differ significantly; SE: Standard error of mean and treatment F_0 (Without fertilizer), F_1 (Medium fertilizer), F_2 (High fertilizer), ADF= acid detergent fiber, NDF= neutral detergent fiber, EE= ether extract.

In Sacco Organic Matter Digestibility of Moringa Oleifera

At the beginning time of digestibility trial digestibility for 0 hrs were tested in the laboratory and found 26.03 \pm 0, 29.05 \pm 0 and 24.79 \pm 0 (%) for F_0 , F_1 and F_2 treatments (Table 4). Digestibility (%) of *M. oleifera* for different treatment groups were investigated by in-sacco technique for 4, 12, 16, 24 and 48 hrs against F_0 , F_1 and F_2 treatments. As the duration of time increase the digestibility of *M. oleifera* increased in all the treatment groups. Results obtained from in-sacco digestion trial revealed that after 4 hrs of digestion there was no variation

of digestibility in different treatment groups. After 12, 16 and 24 hours of digestion, the digestibility of *M. oleifera* varied significantly and treatment F_0 had the lowest ($p<0.05$) digestibility coefficient followed by F_1 and F_2 treatment groups. However, the digestibility coefficient of *M. oleifera* in F_1 and F_2 did not differ significantly ($p>0.05$). After 48 hrs of digestion, the digested value of *M. oleifera* did not differ significantly ($p>0.05$) among the treatment groups. From 0 hr to 48hrs digestion, it was observed that, after 48 hrs of digestion 94.32 % digested value was gained (Table 4).

Table 4. Digestibility (%) of *M. oleifera* for different treatment groups at different time of digestion

Time duration	Mean (\pm SE) for different treatments groups				Level of significance
	F_0	F_1	F_2	Overall	
0 hours	26.03 \pm 0	29.05 \pm 0	24.79 \pm 0	26.62 \pm 1.27	-
4 hours	38.59 \pm 0.55	37.71 \pm 0.74	36.27 \pm 0.79	37.52 \pm 0.53	NS
12 hours	71.33 ^a \pm 1.40	77.72 ^b \pm 0.48	82.79 ^b \pm 0.03	77.28 \pm 2.14	*
16 hours	76.24 ^b \pm 0.66	81.09 ^{ab} \pm 1.21	85.10 ^a \pm 1.54	80.81 \pm 1.70	*
24 hours	87.51 ^b \pm 0.01	90.12 ^a \pm 0.40	90.63 ^a \pm 0.05	89.42 \pm 6.19	*
48 hours	91.75 \pm 0.26	94.32 \pm 0.76	93.07 \pm 0.89	93.04 \pm 0.56	NS

Significant level= (Non Significant= $P>0.05$; *= $P<0.05$, significantly different; ^{ab} values with different superscripts in the same row differ significantly; SE: Standard error of mean and treatment F_0 (Without fertilizer), F_1 (Medium fertilizer), F_2 (High fertilizer)

IV. CONCLUSION

From the above findings, it may be concluded that medium doses of fertilizer (F_1 ; N:P:K at a ratio of 90:30:15) is suitable for optimum production of *M. oleifera* during autumn in its decreasing temperature and humidity. Moreover, in-depth and advanced extended research is required to know the actual impact of weather on biomass production of *M. oleifera*.

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