INTERNATIONAL JOURNAL OF HEALTH & ANIMAL SCIENCE & FOOD SAFETY

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI SCIENZE VETERINARIE PER LA SALUTE, LA PRODUZIONE ANIMALE E LA SICUREZZA ALIMENTARE

KEYWORDS

Season, Fertilizer, Biomass production, Chemical composition, Weather.

PAGES

12 – 23

REFERENCES

Vol. 4 No. 1 (2017)

ARTICLE HISTORY

Submitted: January 17, 2017
Revised: May 21, 2017
Accepted: May 24 2017
Published: May 30 2017

CORRESPONDING AUTHOR

Nazmul Huda, *Scientific Officer, Animal Production Research Division, Bangladesh Livestock research Institute*

Savar, Dhaka, Bangladesh
Postal Code: 1341
Web: www.blri.gov.bd

mail: hudanazmul1971@gmail.com
phone: + +88019358388744

JOURNAL HOME PAGE

riviste.unimi.it/index.php/haf

Article

Seasonal Weather Impacts on Biomass Production of Moringa oleifera at Different Fertilizer Doses

Nazmul Huda[1,*], Khan Shahidul Haque[1], Biplob Kumer Roy[1], Nathu Ram Sarker[1]

[1] *Bangladesh Livestock Research Institute, (BLRI), Savar, Dhaka, Bangladesh*

Abstract

A year round agronomical trial was conducted on station (Bangladesh Livestock Research Institute) to investigate the impact of seasonal variations on biomass production of Moringa oleifera at different fertilizer doses in Bangladesh. A 6×3 factorial arrangement in a completely randomized design (CRD) was applied on 20m×12m =240 m2 size plot, established in 2006 with a plant density of 13,500/hectare, was equally divided into 18 sub-plots and randomly grouped into three; 6 plots was treated as control, 6 plots was treated as medium with medium doses of fertilizer and rest 6 was treated as high fertilizer dose with the ratio of N.P.K was 90:30:15 and 160:60:40 kg/ha, respectively. The obtained result revealed that, the summer was the best season and autumn, monsoon and spring was also favorable for getting maximum yield of Moringa oleifera with ambient temperature ranges 27-32°C and fertilization dose N:P:K= 90:30:15 is suitable for optimum moringa production and chemical composition of moringa varied with season and slightly with fertilization.

1 Introduction

Moringa oleifera, one of the fast-growing Indian native trees (Mekonnen, 2002) and the world's most nutrient-rich plant (Foidle *et al.,* 2001) yet discovered, grows faster under the subtropical low lands in South Asia and Africa (Yang *et al.,* 2006) may be used as a cattle feed for increasing meat (Roy *et al.,* 2016) and milk (Mathur, 2006) production and to improve nutritional status (Kakengi *et al.,* 2007) or as a goat feed for increasing their live weight replacing dietary conventional concentrates completely (Sultana *et al.,* 2015) in addition to its other uses like, growth enhancers of other plant (Phiri & Mbewe, 2010), water purifiers (Sutherland, 1989), human herbal medicines (Yongbai, 2011; Sreelatha & Padma, 2009), and a source of natural oil (Farooq & Rashid, 2007) or biodiesel (Rashid *et al.,* 2008). Within 13 known species *Moringa oleifera* Lam. is the most common known and widely distributed utilized species (Fahey, 2005). Moringa, socially known to be a homestead vegetable plant in the country, may be produced as a tree fodder using appropriate agronomical practices (Palada & Cheng, 2003). Getting biomass of foliage it could be grown through direct seeding, transplanting or using hard stem cutting (Palada & Cheng, 2003). Once, twice or all year round flowering occurs depending with seasonal temperature and rainfall (Parotta, 1993). For optimum production well draining soil is required but in most types of soil from acid to alkaline it can grow and prosper even in low nutrient soil that drains quickly having ideal pH 5.5-7.0 in range (Duke, 1983). Dry regions is particularly suitable for moringa production because it can tolerate full sun and very hot weather but doesn't freeze or frost, rarely need watering as it favors rainwater for grown well without irrigation (Saint & Broin, 2010) except during very hot weather when it required irrigation just once a week (Rajakrishnamoorthy *et al.,* 1994). Suitable climate for production is hot and humid ranges 25-35 °C temperature, exceedingly well growth is shown at temperature of 32.5-49.2 °C. Below 21°C the plant growth become dormant and at more than 15°C fluctuating day-night temperature leaves may lose or become yellow and by freezing temperature it killed (Lowell & Sreeja, 2011; Palada & Cheng, 2003; Parotta, 1993). Without fertilizer moringa trees are able to grow successfully (Ramachandran *et al.,* 1980), once established, the deep and far-reaching root system of moringa can gather it's nutrients from the soil efficiently (Palada and Chang, 2003). Though, by applying 7.5 kg farmyard manure and 0.37 kg ammonium sulphate/tree pod yield is possible to increase threefold (Lowell & Sreeja, 2011). Even, biodynamic compost helps to increase yield about 50% compared to ordinary compost (Palada and Chang, 2003). If some supplemental fertilizer and irrigation is applied, best yield can be got under dry and warm condition (Radovich, 2009) with nine cuttings year (Amaglo, 2006). However, Bangladesh as a sub tropical Moringa growing favored country. Annual variations of weather and fertilizer doses may play a significant role on the availability of biomass and its quality and may mitigate the feed scarcity. Season, weather, variety, fertilization and irrigation affects the yields vary widely. Best yield can be get under dry and warm condition if some supplemental fertilizer and irrigation is applied (Radovich, 2009). The highest ($P<0.001$) biomass (BM), dry matter (DM) and crude protein (CP) yield per hectare of moringa was obtained at 1st cutting during autumn season than yielded that of 2nd cutting. The higher ambient temperature (27^{o}C) and humidity (81%) during 1st cutting could be the reason of higher productivity of moringa than 2nd cutting (average temperature 24^{o}C; humidity 60%) The overall BM and DM yield per hectare were reported to be of 3.99 and 0.7 tons, respectively (Huda *et al.,* 2016). In the similar study, Huda et al., (2016)

  ISSN: 2283-3927

also reported that though application of fertilizer did not affects significantly on BM and DM yield but the medium doses of fertilizer (N:P:K at a ratio of 90:30:15) was suitable for optimum production of moringa in respect of BM, DM and CP yield during autumn season compared to control (without fertilizer) and high doses of fertilizer (N:P:K at a ratio of 160:60:40). Here the result presented by the author was drawn only based on the autumn season. But in perspective of Bangladesh considering agro-ecological variance, the overall seasonal impacts on productivity of M. oliefera at different fertilizer doses were unknown and needs to determine through year round in-depth study for building up the suited agronomic cultural practices of *Moringa oleifera*. Therefore, the present study was undertaken to determine the seasonal weather impact on biomass production of *Moringa oleifera* at different fertilizer doses.

2 Materials and Methods

The experiment was carried out 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. The soil was slightly acidic in reaction (pH 5.6-6.5) with silt loam texture. The land was flat, moderate drained and above flood levels. A Moringa plot of 20×12 m2, established in 2006 with a plant density of 13,500/hectare, was equally divided into 18 sub-plots. Keeping randomly 6 of them as a control, 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; and the rest 6 plots with a ratio of 160:60:40, respectively. The experiment was conducted during Autumn, 2013- Monsoon, 2014, and Tripple Super Phosphate (TSP) and Murate of Potash (MP) were mixed with soil after spading (0.06 Kg and 0.03 Kg/plot, respectively) as basal doses. Urea, splitting into two doses, was applied during spading of soil after each harvest, and again after 15 days of foliage growth.

Since the start of the experiment foliages were harvested at 33, 31, 48, 48, 36, 31, 31, 55 and 45 days of intervals on constant intercultural operations like, weeding, irrigation etc. Except rainfall no irrigation were applied and stacked water of heavy rainfall was drained out and for enough precipitation desired moisture remains in the soil during almost the experimental time. The biomass (green foliage) was harvested in a single day each of the cutting from the foot of each stem where the shoots were pruned. Fresh samples were collected and 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). Data on fresh biomass production and daily temperature, humidity and rainfall were recorded, and all the data of weather, biomass and its different nutrients as well were analyzed statically by an ANOVA of a 6×3 factorial experiment in a completely randomized design (CRD) using the GLM Procedures with SPSS, 17 computer software packages.

3 Results

All the year round readings of different weather parameters i.e.: temperature, relative humidity, precipitation, showed highly significant (P<0.001) difference among the season (Table 1). Highest and lowest temperature of the year was found in summer (32°C) and winter (19°C) season, respectively, differed significantly (P<0.001) with other four seasons; whereas the ambient temperature between autumn and monsoon season did not vary significantly (P>0.05).

Table 1: Average daily weather readings of different season

Parameters	Season						SED	Sig.
	Autumn	Late A.	Winter	Spring	Summer	Monsoon		
Tm (oC)	29a	24b	19c	27d	32e	29a	0.20	***
RH (%)	79a	64b	54c	48d	70e	77a	0.50	***
Prec. (mm)	9.07a	2.38b	0.00c	0.92d	7.20e	11.64f	0.77	***

Tm = temperature, RH = relative humidity, Prec. = precipitation, *** = P<0.001, highly significant, [abcd] values with different superscripts in the same row differ significantly; SE: Standard error of mean

The average relative humidity was significantly (P<0.001) higher in autumn and lower in spring season. However, the variation of relative humidity between autumn and monsoon was not significant (P>0.05). The average rainfall precipitation data vary significantly (P<0.01) among the seasons with highest at monsoon (11.64 mm) followed by autumn (9.07 mm), summer (7.20 mm), late autumn (2.38 mm), spring (0.92 mm) and winter (0.00 mm), respectively (Table 1). Variations on yield with season clearly visible in figure 1 showed that seasons as well as their ambient temperature has an impacts on fresh biomass, dry matter, and crude protein yield, and significant (p<0.05) polynomial relations ($y= 0.138\ x^2- 0.8205\ x + 2.4423$, $R^2= 0.3217$; $y= 0.0185\ x^2- 0.0941\ x + 0.3685$, $R^2= 0.2357$; $y= 0.0051\ x^2-0.0247\ x+ 0.0801$, $R^2= 0.4229$, respectively) were observed with the highest and lowest BM, DM and CP yield in Summer and Winter season, respectively; where Autumn and Monsoon showed comparatively higher (P<0.01) production than Spring and Late Autumn season. This figure also shows that ambient temperature over 27°C favored to enhancing yield and at 32°C plants performed best. Irrespective of fertilizer doses, the biomass yield of *Moringa oleifera* in different season varied significantly (P<0.001) with the highest and lowest was in summer (2793.6 kg/ha) and winter (309.7 kg/ha). However, the BM yield of *Moringa oleifera* did not differ significantly (P>0.05) among monsoon, spring and late autumn (1909.2, 1588.1 and 1387.8 kg/ha, respectively) and late autumn and spring (1387.8 and 1588.1 kg/ha) had similar non-significant (P>0.05) trend in between, with significant difference to other season (Table 2). The DM yield of different season was almost similar as BM yield except little more production in spring than monsoon with non- significant difference, so that, highest DM yield was obtained in summer (588.6 kg/ha) followed by autumn (354.7 kg/ha), spring (340.7 kg/ha), monsoon (338.4 kg/ha), late autumn (239.7 kg/ha) and winter (59.2 kg/ha). In case of CP yield, highest and lowest production was also obtained in summer (127.3 kg/ha) and winter (12.5 kg/ha) season with significant (P<0.001) difference to other season; where autumn (70.9 kg/ha) and late autumn

ISSN: 2283-3927

(51.96 kg/ha) had no significant difference in between and autumn also had no significant difference with late autumn, spring (73.38 kg/ha) and monsoon (90.8 kg/ha) but differed with other season significantly (P<0.001) (Table 2).

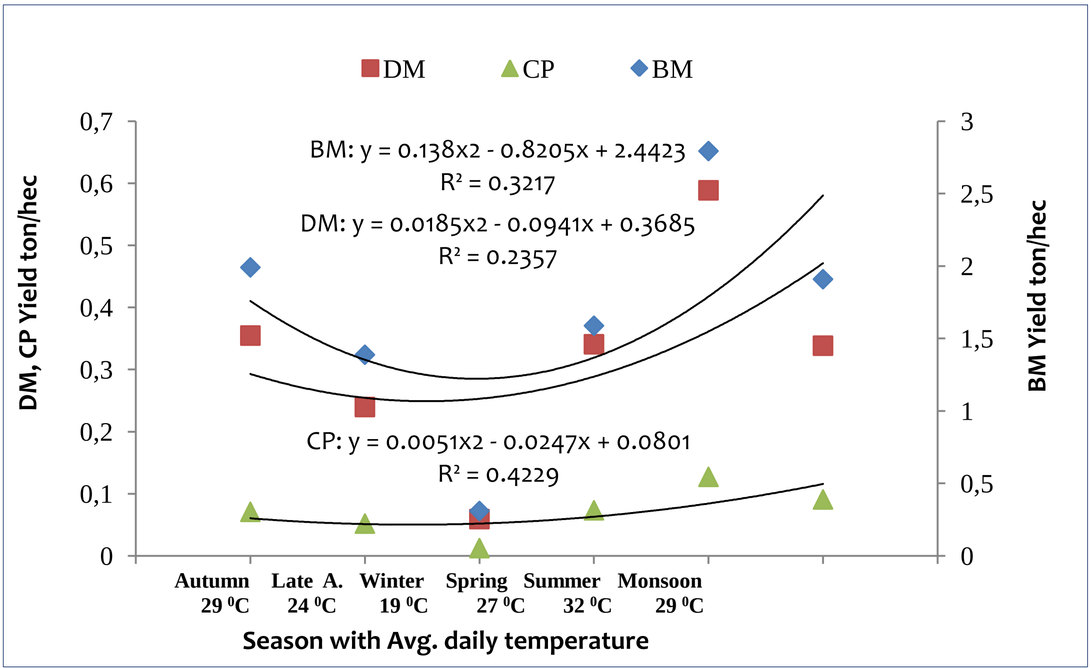

Figure 1: Annual variations in Moringa production

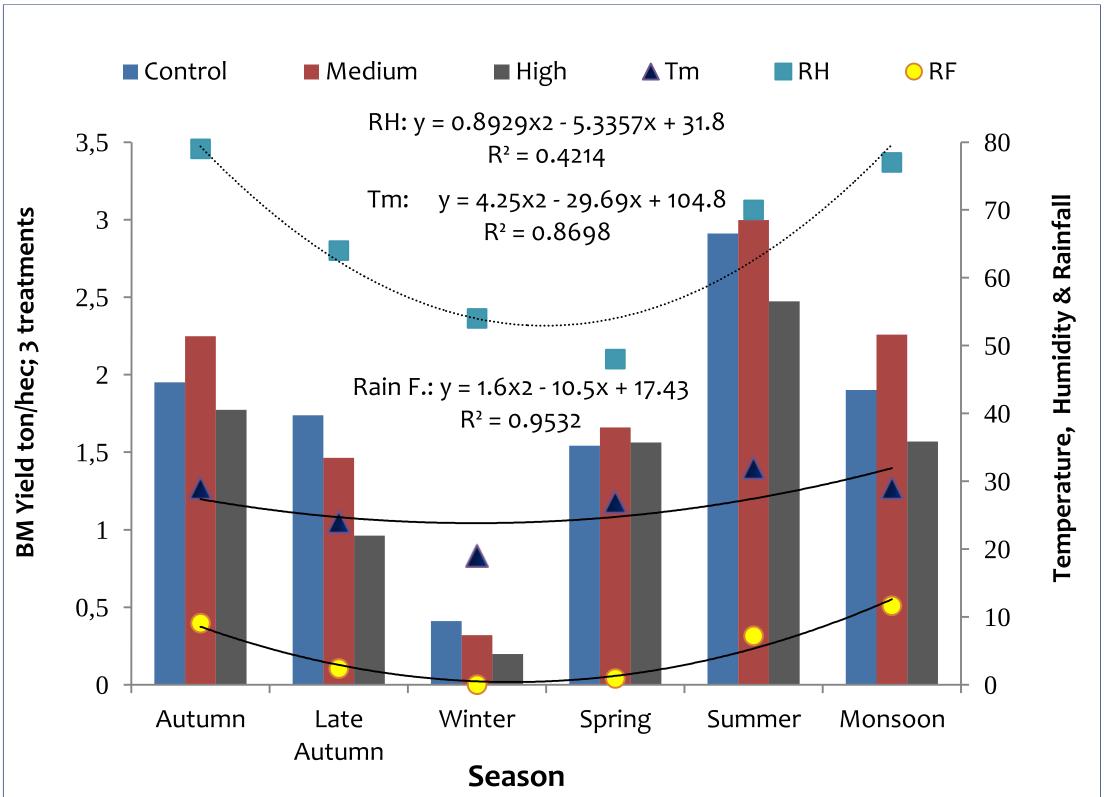

Figure 2: Impact of weather on BM yield in different season with 3 doses of fertilizer.

ISSN: 2283-3927

Table 2: Effect of seasons and fertilizer doses on yield of Moringa Oliefera

Season, fertilizer & their interactions			Parameters: Biomass Yield (Fresh; Kg/ha)	Parameters: DM Yield (Kg/ha)	Parameters: CP Yield (Kg/ha)
Autumn	Fertilizer dose	Control	1951.23	339.95	64.63
		Medium	2247.43	404.17	87.18
		High	1773.56	320.10	60.81
Late Autumn	Fertilizer dose	Control	1737.93	299.55	67.03
		Medium	1462.86	253.16	52.91
		High	962.74	166.37	35.94
Winter	Fertilizer dose	Control	411.35	72.62	15.47
		Medium	318.82	65.06	13.44
		High	198.79	39.97	8.56
Spring	Fertilizer dose	Control	1541.01	327.54	74.36
		Medium	1659.78	363.29	75.66
		High	1563.51	331.35	70.14
Summer	Fertilizer dose	Control	2910.72	643.11	132.41
		Medium	2996.37	622.27	135.26
		High	2473.74	500.55	114.09
Monsoon	Fertilizer dose	Control	1901.72	300.32	81.97
		Medium	2258.06	459.18	123.15
		High	1567.89	255.81	67.39
Season	Autumn		1990.75^{a}	354.74^{a}	70.87^{ad}
	Late autumn		1387.84^{d}	239.69^{d}	51.96^{a}
	Winter		309.66^{b}	59.22^{b}	12.49^{b}
	Spring		1588.11^{d}	340.73^{a}	73.38^{d}
	Summer		2793.61^{c}	588.64^{c}	127.25^{c}
	Monsoon		$1909.23a^{d}$	338.44^{ad}	90.84^{d}
Fertilizer dose	Control		$1742.33a^{c}$	330.52^{ac}	$72.65a^{c}$
	Medium		$1823.89b^{c}$	361.19^{bc}	81.27^{bc}
	High		1423.38^{a}	269.03^{a}	59.49^{a}
SED			95.72	19.02	4.10
Sig.lev.	S		***	***	***
	F		*	*	*
	S×F		NS	NS	NS

Significant level= (Non Significant=P>0.05; *=P<0.05,significantly different; ***=P<0.001, highly significant), [abcd] values with different superscripts in the same row differ significantly; SE: Standard error of mean

The application of fertilizer doses also had a significant (P<0.05) impacts on production in terms of BM, DM and CP yield of *Moringa oleifera*. Irrespective of seasons, significantly (P<0.05) higher BM (1823.9 kg/ha), DM (361.2 kg/ha) and CP (81.3 kg/ha) yield of *Moringa*

 ISSN: 2283-3927

oleifera was obtained by application of medium doses of fertilizer and the lower BM (1423.4 kg/ha), DM (269.0 kg/ha) and CP (59.5 kg/ha) yield was observed by applying the high doses of fertilizer. However, the BM, DM and CP yield of *Moringa oleifera* did not differ significantly ($P>0.05$) between control and medium and control & high doses of fertilizer application. Similarly, the interaction of Season × Fertilizer doses had no significant ($P>0.05$) effect on BM, DM or CP yield. With variant relative humidity, temperature and rainfall biomass yield of different season was varied significantly along with fertilizer doses. Figure 2 shows that, except winter and late autumn, where the yield was little most, biomass yield was obtained most with medium doses of fertilizer in all other four season. And, it is also observed from fig 2 that, humidity, temperature and rainfall had a significant ($p<0.05$) polynomial relationship ($y = 0.8929x2 - 5.3357 x + 31.8$, $R^2 = 0.4214$; $y = 4.25 x2- 29.69 x + 104.8$, $R^2 = 0.8698$; $y= 1.61 x2 – 10.48 x + 17.43$, $R^2= 0.9532$; respectively) with yield of different treatment of fertilizer doses.

The result of chemical composition of moringa plant fodder, irrespective of fertilizer doses, showed highly significant ($P<0.001$) differences among the season in all senses of dry matter, organic matter, crude protein, ash, acid detergent fiber, neutral detergent fiber and ether extract content (Table 3). Irrespective of fertilizer doses, the DM content in moringa plant fodder varied significantly ($P<0.001$) among the seasons. The higher and lower DM content in moringa plant fodder was observed in spring and late autumn, respectively. However, the DM content was not differ significantly ($P>0.05$) among the autumn, late autumn and monsoon seasons; and contained significantly ($P<0.001$) lower DM percentage as compared to winter, spring and summer seasons. The organic matter percentage of autumn and late autumn (92.61 and 92.78, respectively), winter and monsoon (91.06 and 90.79, respectively) & spring and summer (89.87 and 89.67, respectively) was non- significant in- between but these three pairs of season differed significantly ($P<0.001$) with other pairs. Logically, ash percentage maintained the same trend as of OM percentage. The CP, ADF, NDF and EE content in moringa plant fodder were also varied significantly ($P<0.001$) among the seasons. The highest and lowest CP content in moringa plant fodder was found in monsoon (26.78) and autumn (20.31), respectively which differed significantly ($P<0.001$) with each other. On the other hand, CP content in moringa plant fodder did not vary significantly ($P>0.05$) among the late autumn, winter, spring and summer seasons. The ADF content vary ($P<0.001$) from 22.7 to 38.3 on percent dry matter among the different seasons. Monsoon had the higher and late autumn had the lower ADF content in moringa plant fodder. It was also observed an increasing trend of ADF content from late autumn and continued up to monsoon season. In case of NDF and EE, no specific trend was observed in moringa plant fodder under this study. The higher value for NDF and EE was observed in autumn and monsoon and the lower value was in late autumn and summer, respectively. Irrespective of season, the responses of fertilizer doses on nutrient composition of moringa plant fodder revealed that fertilizer doses had no impact ($P>0.05$) on OM, CP, Ash, ADF and EE content except the DM and NDF content in moringa plant fodder. The DM and NDF content influenced significantly ($P<0.001$) by the application of different fertilizer doses. However, significantly higher DM content was obtained in moringa plant fodder when a medium dose of fertilizer was applied in the soil. But no differences ($P>0.05$) for DM content was observed between control and high dose of fertilizer applied in the soil. The highest NDF percentage was found with control fertilizer dose, which was differed significantly ($P<0.001$) with high dose of fertilizer but non- significant with medium dose of fertilizer. Again, medium dose of fertilizer respond non- significantly with high dose of

  ISSN: 2283-3927

fertilizer. Except ADF and EE, the interaction of season and fertilizer doses affected significantly on DM (P<0.05), OM (P<0.05), CP (P<0.05), Ash (P<0.05) and NDF (P<0.001) content in moringa plant fodder.

Table 3: Effect of seasons and fertilizer doses on nutrient composition of Moringa Oliefera

Season, fertilizer & their interactions			Parameters						
			% DM	% OM	% CP	% Ash	% ADF	% NDF	% EE
Autumn	Fertilizer dose	Control	17.47	92.91	19.20	7.09	33.26	58.84	2.91
		Medium	17.94	92.54	21.77	7.46	33.37	57.69	2.76
		High	17.97	92.37	19.95	7.63	29.24	57.49	2.76
Late Autumn	Fertilizer dose	Control	17.32	92.73	22.33	7.27	23.56	44.29	3.05
		Medium	17.34	93.11	20.94	6.89	22.19	37.81	3.02
		High	17.25	92.50	21.40	7.50	22.33	32.05	2.91
Winter	Fertilizer dose	Control	17.62	90.84	21.58	9.16	29.82	51.66	2.34
		Medium	20.14	91.45	20.93	8.54	32.36	49.42	2.23
		High	19.97	90.88	21.58	9.12	28.53	49.43	2.63
Spring	Fertilizer dose	Control	20.90	89.81	22.26	10.19	34.35	50.58	2.89
		Medium	21.85	89.94	20.80	10.06	34.97	52.19	2.85
		High	21.67	89.86	20.86	10.14	36.25	51.83	2.39
Summer	Fertilizer dose	Control	22.14	90.59	20.61	9.41	35.66	51.10	2.45
		Medium	20.90	89.66	21.80	10.34	33.73	54.12	2.22
		High	20.43	88.76	22.95	11.24	35.56	53.49	2.48
Monsoon	Fertilizer dose	Control	15.72	90.55	27.25	9.44	37.46	46.18	4.83`
		Medium	20.88	90.32	26.78	9.68	38.99	45.46	4.45
		High	16.36	91.50	26.31	8.50	38.55	42.63	4.84
Season	Autumn		17.79a	92.61c	20.31b	7.39c	31.96ac	58.01a	2.81a
	Late autumn		17.30a	92.78c	21.56c	7.22c	22.69b	38.05b	3.00a
	Winter		19.24b	91.06a	21.37c	8.94a	30.24a	50.17c	2.40b
	Spring		21.48c	89.87b	21.31c	10.13b	35.19d	51.53cd	2.71a
	Summer		21.16c	89.67b	21.79c	10.33b	34.98cd	52.90d	2.38b
	Monsoon		17.65a	90.79a	26.78a	9.21a	38.33d	44.75e	4.71c
Fertilizer dose	Control		18.53b	91.24	22.21	8.76	32.35	50.44a	3.08
	Medium		19.84a	91.17	22.17	8.83	32.60	49.45ab	2.92
	High		18.94b	90.98	22.18	9.02	31.74	47.82b	3.00
SED			0.19	0.12	0.12	0.12	0.75	0.39	0.06
Sig.lev.	S		***	***	***	***	***	***	***
	F		***	NS	NS	NS	NS	***	NS
	S×F		***	*	*	*	NS	***	NS

Significant level= (Non Significant=P>0.05; *=P<0.05,significantly different; ***=P<0.001, highly significant), [abcd] values with different superscripts in the same row differ significantly; SE: Standard error of mean

ISSN: 2283-3927

4 Discussion

Monsoon and autumn, these two seasons are the best for optimum production of moringa foliage (Chandran, 2013) and suitable climate for production is hot and humid ranges 25-35°C temperature (Lowell & Sreeja, 2011), and even, fresh biomass have a partial correlation with temperature and rainfall averaged over time (Nouman *et al.,* 2013). According the observation of this experiment, summer is the best season for optimum moringa production, where autumn, monsoon and spring are favorable for around maximum moringa production and suitable climate for maximum production is hot and humid ranges 27- 32°C temperature, 70-79 percent relative humidity and 7.2- 11.64 mm avg. daily rainfall. Only spring favored good production with low humidity and rainfall (48% & 0.92 mm, respectively). The result also showed that, fertilizer doses also had a significant ($P<0.05$) impacts on BM, DM and CP yield and with medium doses of fertilizer (N: P: K= 90:30:15 kg/ha) highest yield could obtained. Mendieta et al. 2013 reported that, N fertilization is a key factor for biomass production and other studies also have reported the positive effect of N fertilization on Moringa yield (Dash & Gupta, 2009; Radovich, 2009; Jyothi & Babu, 2007; Pamo *et al.,* 2005). Most recently, Larwanou et al. (2014) noted that actual yields of moringa vary widely, depending on season, variety, fertilization, and irrigation regime. In Nigeria, nitrogen fertilization (Urea) with a rate of 200 kg per hectare were found best for moringa biomass production (Abdullahi *et al.,* 2013) but here in Bangladesh we found 90 kg per hectare is best for moringa production. The result of chemical composition of moringa plant fodder in this experiment, showed highly significant ($P<0.001$) difference among the season in all senses of dry matter, organic matter, crude protein, ash, acid detergent fiber, neutral detergent fiber and ether extract percentage but only DM and NDF percentage was fluctuated by different fertilizer doses. This finding is resembles to Mendieta et al. (2013), who reported that, there were no obvious effects of N fertilization level on CP, ADF and ash content. In this experiment it is also found that, season and fertilizer has an interaction effects on DM, OM, CP, Ash and NDF percentage.

5 Conclusions

From the above result, it may be concluded that, summer was the best season for optimum production of moringa plant fodder and autumn, monsoon and even spring were also favorable for maximum production with ambient temperature ranges 27-32°C and medium dose of fertilizer (N:P:K= 90:30:15) was suitable for optimum moringa production. The study also concluded that chemical composition of moringa plant fodder varied mostly with season and slightly with fertilization.

References

Abdullahi, I.N., Ochi, K., Gwaram, A.B., 2013. Plant population and fertilizer application effects on biomassproductivity of Moringa Oleifera in North-Central Nigeria. In Peak Journal of Agricultural Sciences, 1, 94-100.

Amaglo, N., 2006. How to produce Moringa Leaves Efficiently, Retrieved 2013-11-19. Association of Official Analytical Chemists, Washington D. C.

Chandran, R., 2013. Growing Moringa: issues and constraints. Technologies and practices for small agricultural producers, FAO. World Wide Web: http://teca.fao.org/discussion/growing moringa- issues-and-constraints.

Dash, S., Gupta, N., 2009. Effect of inorganic, organic and bio fertilizer on growth of hybrid Moringa oleifera (PKM 1). In Science, 4, 630–635.

Duke, J.A., 1983. Handbook of energy crops (Moringa oleifera). Center for new crops and plant products. Purdue University, Indiana, US.

Fahey, J., 2005. Moringa oleifera: A Review of the medical Evidence for Its Nutritional Therapeutic, and Prophylactic Properties. Part 1. Trees for Life Journal. [Accessed on July 23, 2008]. [Online] World Wide Web: http://www.tfljournal.org/article.php/ 20051201124931586.

Farooq, A., Rashid, U., 2007. Physicochemical characteristics of Moringa oleifera seeds and seed oil from a wild provenance of Pakistan. In Pakistan J. Bot., 39, 1443–1453.

Foidle, N., Makkar, H.P.S., Becker, K., 2001. The potential of Moringa oleifera for agricultural and industrial uses. Moringa Oleifera World Wide Web: http://miracletrees.org/ moringadoc/the_potential_of_moringa_oleifera_for_agricultural_and_industrial_uses.pdf.

Huda, N., Hashem, M. A., Huque, K. S. and Roy, B. K., 2016. Study on Effects of Fertilizer on Production Performance of Moringa Oleifera (Moringa Oleifera Lam.) In Autumn Season. Int. J. Agri. Innovations and Research., 5(1): 2319-1473.

Jyothi, G., Babu, R., 2007. Graded doses of nitrogen on drumstick (Moringa pterygosperma Goertn Var PKM-1). In J. Res. ANGRAU, 35, 111–113.

Kakengi, A.M.V., Kaijage, J.T., Sarwatt, S.V., Mutayoba, S.K., Shem, M.N., Fujihara, T., 2007. Effect of Moringa oleifera leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. In Livestock Research for Rural Development, 19, no. 8.

Larwanou, M., Adamou, M.M., Abasse, T., 2014. Effects of fertilization and watering regimes on early growth and leaf biomass production for two food tree species in the Sahel: Moringa oleifera Lam. and Adansonia digitata L. In Journal of Agricultural Science and Applications. J. Agric. Sci. Appl, 3, 82-88.

Lowell, J., Fuglie, K.V., Sreeja, 2011. Cultivation of Moringa. World Wide Web: http://miracletrees.org/growing_moringa_content.html.

Mathur, B., 2006. Moringa for Cattle Fodder and Plant Growth. President, Trees for life. World Wide Web: http://www.tfljournal.org/files/Moringa%20for%20fodder%20%26%20spray%20 (screen). Pdf.

Mekonnen, Y., 2002. The multi- purpose moringa tree: Ethiopia (Project 1996-2002). Institute of Pathobiology, Addis Ababa University. Volume 10: Examples of the development of pharmaceutical products from medicinal plants, 111-118.

  ISSN: 2283-3927

Mendieta-ararica, B., Spo`rndli, E., Reyes-sa`nchez, N., Salmero`n-miranda, F., Halling, M., 2012. Biomass production and chemical composition of Moringa oleifera under different planting densities and levels of nitrogen fertilization. In Agroforest Syst., Received: 19 April 2011 / Accepted: 21 May 2012, Springer Science+Business Media B.V. 2012. DOI 10.1007/s10457-012-9525-5.

Nouman, W., Siddiqui, M.T., Basra, S.M.A., Farooq, H., Zubair, M., Gull, T., 2013. Biomass production and nutritional quality of Moringa oleifera as a field crop. In Turkish Journal of Agriculture and Forestry. Turk J Agric, 37, 410-419.

Palada, M.C., Chang, L.C., 2003. Suggested Cultural Practices for Moringa. Asian Vegetable Research & Development Center (AVRDC). In International Cooperators'Guide, 3, 545.

Pamo, E., Boukila, B., Tonfack, L., Momo, M., Kana, J., Tendonkeng, F., 2005. Influence de la fumure organique, du NPK et du me´lange des deux fertilisants sur la croissance de Moringa oleifera Lam. dans l'Ouest Cameroun. In Livest. Res. for Rural Dev, 17.

Parotta, J.A., 1993. Moringa oleifera Lam, Reseda, horseradish tree, Moringaceae, Horseradish tree family. USDA Forest Service, International Institute of Tropical Forestry. Retrieved 2013-11-20.

Phiri, C., Mbewe, D.N., 2010. Influence of Moringa oleifera leaf extracts on germination and seedling survival of three common legumes. In Int. J. Agric. Biol., 12, 315–317.

Radovich, T., 2009. Farm and Forestry Production and Marketing Profile for Moringa (Moringa oleifera). Permanent Agriculture Resources (PAR), PO Box 428, Holualoa, Hawai'i 96725, US, Retrieved 2013-11-20. World Wide Web: http://eol.org/pages/486251/details.

Rajakrishanamoorthy, V., Santhanabosu, S., Duraisamy, V.K., Rajagopal, A., 1994. Drip irrigation in annual moringa. In Madras Agri. J., 81, 678-679.

Ramachandran, C., Peter, K.V., Gopalakrishnan, P.K., 1980. Drumstick (Moringa oleifera): A multipurpose Indian vegetables. In Economic Bot., 34, 276-283.

Rashid, U., Anwar, F., Moser, B.R., Knothe, G., 2008. Moringa oleifera oil: A possible source of biodiesel. In Bioresource Technol., 99, 8175–8179.

Roy, B.K., Bashar, M.K., Hossain, S.M.J., Huque, K.S., Makkar, H.P.S., 2016. Performance Evaluation of Moringa oleifera and Available Roughages (Maize and Australian Sweet Jumbo) on Feeding Values of Growing BLRI Cattle Breed-1 (BCB-1) Bull. In American J. Experimental Agric., 14, Article no. AJEA.29284.

Saint-saveur, A., Broin, M., 2010. Growing and processing moringa leaves. Moringanews/Moringa Association of Ghana. World Wide Web: http://miracletrees.org/ moringa.doc/moringa_book_growing_and_processing_moringa_leaves. pdf.

Sreelatha, Padma., 2009. Antioxidant Activity and Total Phenolic Content of Moringa oleifera Leaves in Two Stages of Maturity. In Plant Foods Human Nutr., 64, 303–311.

Sultana, N., Alimon, A.R., Huque, K.S., Sazili, A.Q., Yaakub, H., Hossain, J., Baba, M., 2015. The Feeding Value of Moringa (Moringa Oleifera) Foliage as Replacement to Conventional Concentrate Diet in Bengal Goats. In Adv. Anim. Vet. Sci., 3, 164-173.

ISSN: 2283-3927

Sutherland, J.P., Folkard, G.K., Grant, W.D., 1989. Seeds of moringa species as naturally occurring flocculants. In Sci. Technol. Dev., 7, 191–197.

Yang, R.Y., Chang, L.C., Hsu, J.C., Weng, B.B.C., Palada, M.C., Chadha, M.L., Levasseur, V., 2006. Nutritional and Functional Properties of Moringa leaves-from germplasm, to plant, to food, to health. In Proceedings of the International Workshop "Moringa and other highly nutritious plant sources: strategies, standards and markets for a better impact on nutrition in Africa". Accra, Ghana.16-18, 1-9.

Yongbai, K.A., Lewis, D.M., Harris, P.L., 2011. Application of Phytodisinfectants in Water Purification in Rural Cameroon. In African Journal of Microbiology Research. 5, 628-635.

ISSN: 2283-3927