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Morphological characteristics of different accessions of *Cynodon dactylon* (L.) Pers. and physico-chemical properties of soil of their growing region in Bangladesh

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Abstract

Distribution as well as adaptation of *Cynodon dactylon* to different ecological zones of Bangladesh is mainly dependant on weather and adaphic factors of their respective habitats. Generally, it is a warm season perennial grass species that initiates growth in the vernal season and its growth continues rapidly when moisture is adequate and they find the alkaline clay soil as their habitat. From that point of view, this study was aimed at analysing the morphological variations of *Cynodon dactylon* ecotypes along with determining the physicochemical properties of soils from their particular habitats. A total of 19 ecotypes /accessions from four different zones of Bangladesh were collected along with the habitat soil and all of them were transplanted in experimentation field of Institute of Biological Sciences, University of Rajshahi, Bangladesh. All the accessions were established in 1.5 × 1.4 m plots separately. At maturity just after started flowering, the morphological data on 26 characters were recorded quantitatively and those were analysed statistically. Rhizomatous and stoloniferous nature was observed from randomly selected areas within the plot. Both significant and non-significant variations were found among the morphological characters. Most of the vegetative and reproductive characters were found to show significant variations among the accessions. In addition, the values obtained on physio-chemical properties of soil were tabulated and their magnitude were determined and interpreted following Fertilization Recommendation Guide. In respect of soil properties variation on morphological parameters of almost of all the accessions were observed. In this study, all the accessions were found to be adapted nicely in alkaline soil of the experimentation field and that might be due to their many physiological and biochemical mechanisms.

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Introduction

Cynodon dactylon (L.) Pers is a prostrate and perennial grass. It spreads by scaly rhizomes and flat stolons, and widely naturalized in tropical and subtropical regions of the world. This plant species is a C_4 grass included in the Global Compendium of Weeds (Randall, 2012) and it is listed as one of the most serious agricultural and environmental weeds in the world (Holm *et al.*, 1977).

This grass species has different vernacular names. In Bengali, it is known as Durva, Dub, Dubla, Durba, Doorva, Neel Doorva (Asthana *et al.* 2012). In English it is termed as Couch grass, Bahama grass, Bermuda grass, Dun grass, Doab grass etc. The common name for all the East African rhizomatous species of *Cynodon* is Bermuda grass (Harlan, 1970; Burton and Hanna, 1985). *Cynodon dactylon* however, has become a ubiquitous cosmopolitan weed (Harlan and de Wet, 1969).

Cynodon dactylon can tolerate wide range of soil types and their growth becomes healthy on heavy clay soil than on light sandy soil in dry regions and this might be due to water holding capacity of clay (Burton and Hanna ,1985). However, alkaline soils are tolerated nicely by this grass species than acidic ones. Drought conditions, high temperature, intensive sunlight and alkaline soils are found to be best requirements for healthy growth of this grass. *Cynodon dactylon* shows direct competition for space and nutrients by its rapid growing ability and adaptive capacity.

Cynodon dactylon is found with underground rhizomes and on ground runners (Cabrera, 1968; Covas and Salavi,1970).These rhizomes penetrate to the soil of a depth of above 30 cm(Perez and Labrada,1985; Philips and Moaisi,1993). The rhizomes may be twice as wide as the runners and this is found to be one of the variable characters in their populations. Runner or rhizome nodes generally bear up to three viable buds. Leaves show alternate distal pattern of distribution along the runners. Leaf blades are unhaired but the ligule is found with a conspicuous fringe of white hairs. Leaf blades are green to dull green, lanceolate, finely parallel-ribbed on both the surfaces, without midrib (Rosengurt *et al.*, 1960). The inflorescence is supported on a culm and consists of a single whorl of 3-7 racemes. Spikelets are closely appressed to the rachis. Glumes are one nerved, lemma is silky pubscent on the keel and palea is glabrous. Caryopses are sub-eliptical, compressed and brownish in colour (Kissmann, 1991).

Cynodon dactylon has some sort of social impact, as its pollen has been found to cause allergic symtoms in asthmatics in Malaysia (Sam-Choonkook *et al.*, 1998) and Brazil (Kissmann, 1991). The use of *Cynodon dactylon* in different religious ceremonies has been studied by Dubey *et al.* (2000).This grass species is used medicinal plant and antioxidant of *C. dactylon* used for management of neurodegenerative diseases has been studied extensively by Auddy *et al.* (2003). This plant species is used as pasture grass in many countries, since it contains many soils of chemical components like proteins, carbohydrates, mineral constituents phosphorous, calcium, potassium, vitamin C, carotene, fats, palmitic acid etc. Paranjpe (2001) reported a good amount of crude protein,fiber and total ash.

Cynodon species have been classed as noxious weeds, especially *C. dactylon*, which is very invasive (Fernaudez, 2003). This species is suitable for erosion control and soil stabilization. But mechanical tillage of weed-infested fields makes an effect on fragmentation and dispersal of stolon and rhizome propagules, and thereafter infestation is increased.

However, Van De Wouw *et al.* (2009) stated that, the International livestock Research Institute (ILRD) collected some commercial cultivars and accessions of *Cynodon* species from wild habitats. These collections cover four different species of *Cynodonviz.C. aethiopicus*, *C. dactylon*, *C. incompletus* and *C. nlemfuensis* along with hybrids of *C. dactylon* and *C. transvaalensis*. The concerned investigators determined the amount of morphological variation present in the collections, based on what the users can select the appropriate accessions for their further experiment. The objective of the present study was to make an analysis of morphological variation of *C. dactylon* ecotypes from botanic as well as agronomic points of view, and their determination of physico-chemical properties of their habitat soils.

Material and methods

Study sites

A total of 19 ecotypes of *Cynodon dactylon* were collected from 04(four) different zones of Bangladesh. Selection was based on environmental conditions of the collection site. The selective districts were presented in Table 1.

The study was carried out at the research field of IBSc, Institute of Rajshahi University. The site has an annual average rainfall of 661.2 mm of which the majority falls during the main rainy season (July-September). No fertilizers were used in the experimentation field. The soil at the research field is loamy soil. All (19) the accessions of *C. dactylon* were established from root splits in 1.5m ×1.4m plots, collected from 19 habitats belonging to 04(four) zones. Data were recordedon 26 characters. The characters were selected for their agronomic/taxonomic relevance and expected variation among accessions. The morphological characters were observed within the first 4 months just after cutting before most accessions had started flowering. Owing to the rhizomatous and stoloniferous nature of *Cynodon dactylon* it was difficult to identify individual plants. So, observations were made randomly within the plot. Six randomly selected areas of 25cm ×25 cm in the plot were chosen for rhizome observations and six randomly selected areas of 200cm×50cm at the end of the plot for stolon observations. Plants were removed from three areas at the time of cutting and after 7 weeks the numbers of rhizomes or stolon in the selected areas were counted. The collected ecotypes were grown under same environmental conditions at research field of IBSc Institute of Rajshahi University, till their acclimatization to evaluate genetically fixed characteristics during long evolutionary history. Plants were uprooted carefully and washed with distilled water. For dry weight, plant samples were oven-dried at 65°c for 48 hours and constant dry weight was achieved. Data were recorded of the following plant parts and their mean values were tabulated (Table 2).

For determination of the leaf area single segment of leaf was cut off with the help of a sharp knife, weighted after oven -drying and then it was calculated by using the following formula:

$$\text{Leaf area} = \frac{\text{Area of segment} \times \text{weight of leaves}}{\text{Weight of segment}}$$

Analysis of soil samples

Soil from rhizosphere was taken from each habitat to analyze the physico-chemical characteristics at 16 cm depth. The soil extract was used to determine the pH, organic matters %, potassium(K^+), Calcium (Ca^{2+}), Magnesium (Mg^{2+}) total nitrogen, phosphorus(P), Sulfur (S), Boron(B), Copper (Cu), Iron (Fe), Manganese (Mn) and Zink (Zn) of soil.The19 different soil samples were collected from 19 different habitats. Then collected soil was air-dried for 7 days and then sieved using a 2mm mesh to remove debris. Air-dried and sieved soil (250gm) was used for soil analysis. Soil pH was measured by HANNA HI 92210N ATC pH Meter. Total organic matter was determined following the wet oxidation method as described by Walkley and Black (1934) and the micro Kjeldahi procedure was used for the determination of total nitrogen (Bremnerv and Mulvaney, 1982). Available phosphorus, sulfur and boron were measured by using spectrophotometer at 890nm.Magnesium, Calcium, Manganese, Copper, Iron and Zinc were obtained using atomic absorption spectrophotometer (Perkin- Elmer Model 403, Shelton, Connecticut, USA).

Available Potassium was measured by using a flame photometer. Phosphorus was determined following the Olsen method [pH = 6.6 – 7.3 (Neutral),6.5>, (Acidic)7.4<(Alkaline) and Organic matter (OM) =below 1- Very low, 1-1.7 –Low, 1.8-3.4 -Medium, 3.4<High].

A change of pH and oxidation state can increase or decrease the potential bioavailability of metals in soil. Metals such as Zn, Cu, and Mn are essential for living organisms at low concentrations, but became toxic of increasing concentrations. The soil test values were interpreted based on critical limits following Fertilization Recommendation Guide (Table 3).

Statistical analysis

A statistical comparison of means of different accessions and their characters was carried out using analysis of variance (ANOVA) followed by Dunkan's Multiple Range Test (DMRT). Significance level was set at $p<0.05$. The data analysis was done busing SPSS version 20.0 for Windows. Graphs were drawn by Excel software.

Results

The accessions showed variation in many of the morphological characters (Tables 4-8). Shoot number, shoot length, node number, internode length and fresh and dry weight of shoot were found with higher values in the accessions collected from Lalmonirhat, Rajshahi, Gazipur and Thakurgaon, respectively (Table 4). On the contrary, lower values of these characters were found in the accessions collected from Panchagarh, Dinajpur, Panchagarh and Dinajpur again, Dinajpur and Shariatpur, respectively. Regarding shoot characters the variations are also shown based on geographical zones (Fig. 1).

Table 1. Nineteen districts considered as habitat of the accessions of *C. dactylon* under four different zones of Bangladesh.

North zone	West zone	East zone	South zone
Rangpur	Rajshahi	Gazipur	Khulna
Lalmonirhut	Naogaon	Narshingdi	Jessore
Dinajpur	Pabna	Sherpur	Jhenaidah
Thakurgaon		Mymensingh	Faridpur
Panchagarh			Shariatpur
Gaibandha			Barguna

Table 2. Twenty six different quantitative characters of each accession considered for recording both vegetative and reproductive attributes.

1	Number of shoots/plant	14	Total leaves fresh weight/ plant(g)
2	Shoot length(cm)	15	Shoot dry weight/plant(g)
3	Number of nodes/plant	16	Root dry weight /plant(g)
4	Internode length(cm)	17	Total leaves dry weight /plant(g)
5	Root length	18	Inflorescence number /plant
6	Number of roots/plant (cm)	19	Length of racemes (cm)
7	Number of leaves/plant	20	No. of racemes /plant
8	Single leaf length(cm)	21	Seed number /shoot
9	Single leaf width(mm)	22	Seed number /plant
10	Total leaf area/plant(cm2)	23	Maximum height(cm)
11	Number of rhizomes /plant	24	Minimum height(cm)
12	Shoot fresh weight /plant (g)	25	Number of stolons
13	Root fresh weight/plant(g)	26	Stolon length

Table 5 reveals higher values for root number, root length, fresh and dry weight of root and rhizome number in case of the accessions collected from Khulna, Faridpur, Rajshahi and Khulna, respectively. Lower values were obtained for root number in accessions of Gaibandha, for root length in case of Rajshahi, fresh weight in case of Shariatpur, dry weight in case of Gazipur and for rhizome number in the accession collected from Sherpur.

The variations in root characters are shown in Fig. 2 based on zone (Fig. 2).

Table 2. Morphological variation of 19 accessions of *Cynodon dactylon* shoot collected from different habitats of Bangladesh.

Zone (Bangladesh)	Name of District	Parameters of shoot (Mean)						
		Number	Length (cm)	No. of node	Internode length (cm)	Colour	Fresh weight (gm)	Dry weight (gm)
North	Rangpur	8.50abcdef	14.72cd	6.00ab	2.52a	Green	4.31bcd	1.4b
	Lalmonirhat	*12.00a*	16.13bc	4.50b	2.73a	Green	4.83bcd	1.82ab
	Dinajpur	7.67cdef	10.66f	4.17b	1.44a	Green	2.95d	1.05b
	Thakurgaon	6.83def	19.45ab	4.83b	2.80a	Green	8.11a	3.48a
	Panchagarh	5.67f	13.92cdef	3.83b	3.23a	Green	3.27cd	1.12b
	Gaibandha	8.17bcdef	14.36cde	4.50b	2.72a	Green, Gray	5.89abc	1.91ab
West	Rajshahi	11.83ab	20.02a	9.17a	2.77a	Green	3.99bcd	1.91ab
	Naogaon	9.33abcdef	14.66cde	4.17b	2.28a	Green	4.14bcd	1.60b
	Pabna	9.50abcde	17.11abc	5.67b	2.12a	Green	5.30bcd	2.01ab
East	Gazipur	6.50def	16.41bc	4.83b	4.13a	Green	4.20bcd	1.29b
	Narshingdi	8.50abcdef	12.48def	4.17b	2.23a	Green	5.86abc	1.94ab
	Sherpur	8.50abcdef	17.42abc	6.67ab	3.48a	Green	5.10cd	1.69ab
	Mymensingh	9.00abcdef	16.12bc	6.17ab	2.73a	Green, Gray	6.64ab	2.65ab
South	Khulna	7.67cdef	15.72cd	5.50b	2.42a	Green	4.64bcd	1.75ab
	Jessore	6.67def	15.56cd	4.67b	2.08a	Brown	3.79bcd	1.65b
	Jhenaidah	5.83ef	16.15bc	5.33b	2.78a	Green	4.58bcd	1.44b
	Faridpur	10.67abc	16.33bc	4.17b	2.15a	Green	3.11cd	1.1b
	Shariatpur	8.50abcdef	12.03ef	5.23b	2.50a	Green	2.57d	0.81b
	Barguna	9.67abcd	15.88cd	5.83ab	3.32a	Green	6.17ab	2.13ab

In case of flower characters, spikelet colour was found to vary (Table 6). Highest value for number of inflorescences was found in accession collected from Mymensingh and lowest in that of Panchagarh. Highest and lowest values for number of racemes were found in the accessions collected from Rajshahi and Lalmonirhat respectively. For length of racemes highest and lowest values were found in the accessions of Gazipur, Khulna and Rajshahi respectively. Number of seeds per shoot and per plant was found to be highest and lowest in the accessions collected from Jessore and Gaibandha, and from Faridpur and Barguna, subsequently. Fig. 3 reveals that the number of seeds per shoot and per plant were highest in accessions collected from east and south zone. Figure 4 also shows similar results with a little variation in case of inflorescence and raceme characters.

In case of leaf characters (Table 7) number of leaves, leaf width, total leaf area and leaves dry weight were found with highest values in the accession collected from Rajshahi. On the other hand, lowest values for these characters were found in that case of Faridpur, Sherpur, Jessore and Jessore again, successively.

Values for leaf length and leaves fresh weight were highest for the accession of Faridpur and Panchagarh, lowest values were found for these characters in case of Pabna and Jessore, respectively.

Table 3. Morphological variation of 19 accessions of *Cynodon dactylon* root collected from different habitats of Bangladesh.

Zone (Bangladesh)	Name of District	Parameters of Root (Mean)				
		Number of Root	Length (cm)	Fresh weight (gm)	Dry weight (gm)	Number of Rhizome
North	Rangpur	14.17abcd	10.77ab	1.93b	0.71b	4.00def
	Lalmonirhat	15.00abc	10.25ab	1.60b	0.76b	4.33def
	Dinajpur	9.50de	8.50abc	1.28b	0.58b	9.00ab
	Thakurgaon	14.17abcd	11.10ab	2.29b	0.85b	9.17ab
	Panchagarh	9.67de	8.92abc	1.71b	0.72b	3.33ef
	Gaibandha	8.00e	6.65bc	2.08b	0.82b	5.20bcdef
	Rajshahi	14.83abc	4.92c	4.61a	2.37a	7.50bcd
West	Naogaon	11.50bcde	11.05ab	1.73b	0.63b	7.33bcde
	Pabna	11.00cde	8.50abc	1.69b	0.73b	8.83ab
East	Gazipur	13.50abcd	10.25ab	1.22b	0.47b	4.00def
	Narshingdi	15.00abc	6.98bc	1.30b	0.62b	6.33bcdef
	Sherpur	16.00ab	9.30abc	1.63b	0.67b	3.00f
	Mymensingh	11.50bcde	10.68ab	1.48b	0.64b	4.17def
South	Khulna	16.67a	8.92abc	1.61b	0.59b	11.50a
	Jessore	13.50abcd	6.88bc	1.25b	0.53b	5.33bcdef
	Jhenaidah	12.83abcde	10.00abc	1.80b	0.49b	4.50cdef
	Faridpur	11.33bcde	12.77a	1.49b	0.61b	8.33abc
	Shariatpur	11.17bcde	11.48ab	0.91b	0.61b	5.50bcdef
	Barguna	10.67cde	10.53ab	2.15b	0.90b	5.33bcdef

Table 8 reveals plant height (maximum and minimum), and number of stolons per plant and stolon length. Plant height was found with maximum and minimum values in accession of Thakurgaon. Value for stolon per plant was found to be highest in accession collected from Mymensingh and lowest value was found for stolon length in the accession of Khulna. Growth habit of all the 19 accessions showed erect and prostrated nature based an angle of stem to ground.

Table 4. Morphological variation of 19 accessions of *Cynodon dactylon* flower and seed collected from different habitats of Bangladesh.

Zone (Bangladesh)	Name of District	Parameters of Flower (Mean)				Parameters of Seed (Mean)	
		No. of Inflorescence /plant	No. of racemes	Length of racemes (cm)	Spikelet colour	No. of Seeds/ Shoot	No. of Seeds/ plant
North	Rangpur	3.6ab	4.02a	4.00a	Brown	90.40de	325.60f
	Lalmonirhat	5.0ab	3.73a	3.42a	Green, Brown, Dark Brown	73.60hi	338.80e
	Dinajpur	3.6ab	3.88a	3.07a	Light Green, Brown	73.40hi	264.00i
	Thakurgaon	4.8ab	4.18a	3.54a	Brown, Light Green	77.48h	319.80g
	Panchagarh	2.0b	4.10a	4.27a	Brown	88.90ef	177.80l
	Gaibandha	2.8b	3.80a	3.60a	Brown	66.10k	182.20l
West	Rajshahi	3.8ab	5.95a	2.77a	Green, Brown	88.28efg	318.60g
	Naogaon	3.0b	4.05a	3.67a	Brown	85.44efg	244.00j
	Pabna	4.0ab	3.92a	3.17a	Light Green, Brown	86.39efg	325.00f
East	Gazipur	2.8b	3.93a	4.47a	Brown	83.70fg	214.60k
	Narshingdi	3.0b	4.25a	3.84a	Brown, Greenish Brown, Dark Brown	99.06c	290.60h
	Sherpur	5.6ab	4.41a	3.30a	Brown, Light Green, Dark Brown	83.51fg	470.80c
	Mymensingh	7.2a	4.12a	3.03a	Light Green, Brown	71.53i	525.40b
South	Khulna	2.6b	4.00a	4.47a	Brown	95.28cd	247.20j
	Jessore	3.6ab	4.01a	3.93a	Brown, Light Brown, Light Green	113.72a	392.00d
	Jhenaidah	2.8b	4.40a	4.24a	Brown, Dark Brown, Light Green	105.70b	259.00i
	Faridpur	5.0ab	4.51a	3.90a	Brown, Light Green	109.32ab	537.80a
	Shariatpur	4.8ab	4.04a	2.98a	Brown, Light Green	82.96g	393.80d
	Barguna	2.6b	4.27a	3.26a	Brown, Green, Light Green	68.10ij	172.40m

Among all the accessions only 08(eight) accessions showedtheir both the growth habit in the ratio of 1:1 or 2:1, and rest of them were either erect or prostrated. Variation in plant height and stolon characters are visualized in Fig. 7.

The ANOVA analysis for shoot and root characters showed the significant variations (Table 9) for number of shoots, shoot length, fresh weight of shoot, number of root and number of rhizomes.

Table 5. Morphological variation of 19 accessions of *Cynodon dactylon* leaf collected from different habitats of Bangladesh.

Zone (Bangladesh)	Name of Dist.	Parameters of Leaf (Mean)						
		No. of Leaves/ plant	Leaf length (cm) (single)	Leaf width (mm) (single)	Total Leaf Area (cm²)	Total leaves fresh weight /plant(gm)	Total leaves dry weight/ plant(gm)	Leaf Nature (soft/ stiff)
North	Rangpur	22.67fg	4.78a	1.82a	224.25g	1.73a	0.39a	Soft
	Lalmonirhat	39.50b	4.90a	2.00a	242.45e	2.24a	0.37a	Soft
	Dinajpur	20.00gh	4.77a	2.03a	200.10i	1.53a	0.31a	Stiff
	Thakurgaon	23.50defg	5.68a	2.07a	154.30m	1.61a	0.24a	Soft
	Panchagarh	27.83cd	4.73a	2.30a	346.60b	2.49a	0.48a	Soft
	Gaibandha	27.67cde	4.33a	2.02a	161.12l	1.89a	0.31a	Soft
West	Rajshahi	80.33a	5.40a	2.67a	414.70a	2.39a	0.51a	Soft
	Naogaon	13.50j	4.82a	2.28a	345.40b	2.33a	0.49a	Soft
	Pabna	15.67ij	3.75a	2.02a	249.50d	1.79a	0.45a	Soft
East	Gazipur	25.17cdef	4.72a	2.02a	188.50k	1.69a	0.30a	Soft
	Narshingdi	19.33ghi	4.88a	2.03a	238.35f	1.61a	0.38a	Soft
	Sherpur	25.33cdef	5.23a	1.58a	211.15h	1.70a	0.42a	Soft
	Mymensingh	17.17hij	5.05a	2.20a	196.20j	1.52a	0.33a	Soft
South	Khulna	27.33cde	5.37a	2.00a	280.65c	1 .70a	0.46a	Soft
	Jessore	23.17efg	4.48a	1.77a	73.02p	1.09a	0.16a	Soft
	Jhenaidah	25.67cdef	5.13a	1.88a	118.05n	1.17a	0.23a	Soft
	Faridpur	9.50k	6.38a	2.17a	189.55k	2.00a	0.29a	Soft
	Shariatpur	24.67def	5.53a	1.78a	91.35o	1.37a	0.16a	Soft
	Barguna	29.50c	5.47a	2.18a	223.60g	1.91a	0.34a	Soft

Rest of the characters showed non-significant variation among all the accessions collected from different habitats. Again, the ANOVA analysis for leaf plant height and stolon characters (Table 10) revealed significant variation for number of leaves, total leaf area and maximum plant height. Other seven characters showed non-significant variation. In case of inflorescence and seed characters only number of seeds per shoot and plant were found to show significant variation (Table 11). Tables 12a and 12b reveals physico-chemical properties of the soil of 19 original habitats along with the experimentation habitat with values and their magnitude of organic and inorganic matters, respectively. The soil of the experimentation field was found to be loamy. Gangetic alluvium comprises the districts of Jessore, Kushtia, Rajshahi, Faridpur, Khulna, Barisal and Dhaka. In this areas soil texture varies from clay loam to sandy loam and pH ranges from 7.0 to 8.5. The pH value of all the habitats were also determined and its highest value 8.5(alkaline) was found in the soil of Narshingdi, which was somewhat highest than that of experimentation habitat, Rajshahi, Jessore, Jhenaidah and Shariatpur.

Table 6. Morphological variation of 19 accessions of *C. dactylon* plant height, stolon and growth habit collected from different habitats of Bangladesh.

Zone (Bangladesh)	Name of dist.	Parameters of plant height (cm) (Mean)		Parameters of stolon (Mean)		Growth habit: Angle of stem to ground (prostrated/erect)
		Maximum height(cm)	Minimum height(cm)	No. of Stolon/plant	Stolon Length	
North	Rangpur	24.03bcd	16.47ab	7.00a	2.94a	Erect
	Lalmonirhat	26.40abc	16.28ab	5.00a	2.72a	Prostrated
	Dinajpur	17.97f	13.35abc	4.67a	2.77a	Erect
	Thakurgaon	29.13a	17.17a	6.83a	3.30a	Erect : Prostrated 2:1
	Panchagarh	22.23cdef	14.53abc	6.83a	3.21 a	Erect
	Gaibandha	21.33def	10.50c	6.20a	2.54a	Erect : Prostrated 1:1
West	Rajshahi	27.02ab	16.75a	7.17a	3.33a	Prostrated
	Naogaon	24.18bcd	16.12ab	4.33a	2.88a	Erect
	Pabna	23.35bcde	12.63abc	6.00a	2.83a	Erect : Prostrated 1:1
East	Gazipur	26.17abc	13.88abc	6.72 a	3.12a	Erect
	Narshingdi	19.02ef	13.43abc	6.5a	3.28a	Erect
	Sherpur	25.87abcd	13.57abc	4.50a	2.90a	Erect : Prostrated 1:2
	Mymensingh	26.05abcd	16.42ab	9.67a	2.83a	Prostrated
South	Khulna	23.62bcd	15.07abc	4.83a	4.41a	Erect : Prostrated 1:1
	Jessore	21.93cef	11.37bc	6.71a	2.70a	Erect : Prostrated 2:1
	Jhenaidah	25.70abcd	16.83a	4.50a	2.85a	Erect
	Faridpur	25.60abcd	13.83abc	7.00a	2.66a	Erect : Prostrated 1:1
	Shariatpur	22.48bcde	17.15a	6.33a	3.32a	Erect : Prostrated 2:1
	Barguna	23.73bcd	14.93abc	6.33a	3.55a	Erect

Table 7. Analysis of variance (ANOVA) subjected to variation of different parameters of shoot and root in *Cynodon dactylon*on the basis of 19 habitats.

Subject	Data source	Source of variation	DF	Mean SS	F value
Shoot	No of Shoot	Habitat	18	9.677	2.627**
		Error	38	3.684	
	Shoot Length	Habitat	18	15.808	4.683***
		Error	38	3.376	
	No. of Nodes	Habitat	18	4.649	1.350^{NS}
		Error	38	3.444	
	Internode Length	Habitat	18	1.075	0.451^{NS}
		Error	38	2.382	
	Shoot Fresh Weight	Habitat	18	5.840	2.719**
		Error	38	2.148	
	Shoot Dry Weight	Habitat	18	1.125	1.311^{NS}
		Error	38	0.858	
Root	No of Root	Habitat	18	17.150	2.712**
		Error	38	6.323	
	Root Length	Habitat	57	11.639	1.643^{NS}
		Error	18	7.085	
	Root Fresh Weight	Habitat	38	1.771	1.492^{NS}
		Error	57	1.187	
	Root Dry Weight	Habitat	18	0.500	1.522^{NS}
		Error	38	0.329	
	No. of Rhizomes	Habitat	57	16.806	3.967***
		Error	18	4.237	

= significant at $p \leq 0.01$, *= significant at $p \leq 0.001$ and NS= non-significant.

The acidic habitats were found in case of Lalmonirhat, Thakurgaon, Panchagarh, Gaibandha, Gazipur and Sherpur.Rest of the habitats were somewhat alkaline. The highest values for organic matter, Potassium, Calcium and Magnesium were found in the soil of Faridpur, Dinajpur, Rajshahi and Dinajpur again, respectively. The total nitrogen was found to highest in the soil of Gazipur, somewhat similar to that of Pabna and Faridpur. The highest values for Phosphorus Sulfur, Boron,Copper and Zinc were found in the soil of Pabna. On the other hand, highest amount of Iron and Manganise were found in the soil of Rangpur and Dinajpur, respectively (Fig. 8).

Table 8. Analysis of variance (ANOVA) subjected to variation of different parameters of leaf, plant height and stolon in *Cynodon dactylon*on the basis of 19 habitats.

Subject	Data source	Source of variation	DF	Mean sum of square	F value
Leaf	No of Leaf	Habitat	18	641.721	110.598***
		Error	38	5.802	
	Leaf Length	Habitat	18	0.972	0.236NS
		Error	38	4.111	
	Leaf Width	Habitat	18	0.170	0.114NS
		Error	38	1.493	
	Total Leaf Area	Habitat	18	22387.091	4716.439***
		Error	38	4.747	
	Total Leaves FW W/plant	Habitat	18	0.450	0.357NS
		Error	38	1.259	
	Total Leaves DW/plant	Habitat	18	0.033	0.551NS
		Error	38	0.060	
Plant Height	Maximum Height	Habitat	18	22.950	3.938***
		Error	38	5.828	
	Minimum Height	Habitat	18	11.804	1.639NS
		Error	38	7.202	
Stolon	No. of Stolon	Habitat	18	5.110	0.611NS
		Error	38	8.370	
	Stolon Length	Habitat	18	0.553	0.117NS
		Error	38	4.723	

***= significant at p ≤ 0.001 and NS= non-significant.

Table 9. Analysis of variance (ANOVA) subjected to variation of different parameters of inflorescence and seeding *Cynodon dactylon* on the basis of 19 habitats.

Subject	Data source	Source of variation	DF	Mean sum of square	F value
Inflorescence	No. of Inflorescence	Habitat	18	5.038	1.474NS
		Error	38	3.417	
		Total	57		
	No. of Racemes	Habitat	18	0.677	0.136 NS
		Error	38	4.974	
		Total	57		
	Length of Racemes	Habitat	18	0.809	0.192 NS
		Error	38	4.221	
		Total	57		
Seed	Seeds no./ shoot	Habitat	18	552.996	58.247***
		Error	38	9.494	
		Total	57		
	Seeds no./plant	Habitat	18	35661.319	3668.259***
		Error	38	9.722	
		Total	57		

***= significant at p ≤ 0.001 and NS= non-significant.

Considering interpretation of soil test values based on critical limits (Table 3) magnitude of physico-chemical properties (12b) the soil of different habitats considered in the present study were estimated.

Discussion

The present study was conducted to evaluate the morphological (both botanic and agronomic) behaviour of 19 collected native populations of *Cynodon dactylon* from 04 (four) different zones of the country regarding the variations among them. Somewhat similar type of works on *C. dactylon* was carried out by Viggiani *et al.* (2015) in Italy. During the first step of research, they identified 11 sites from six regions of Southern and Central Italy and from these sites they collected 24 ecotypes for determining their habitus and phenology plus some biometrical parameters.

Table 10a. Physicochemical properties of soil obtained through soil analysis of habitats in Bangladesh.

Soil of different habitats	P^H	OM (%)	K	Ca	Mg	Total nitrogen (%)	P	S	B	Cu	Fe	Mn	Zn
			C mol (+)/kg				Microgram/gm						
IBSc Field	8.2	1.77	0.13	34.60	1.70	0.10	11.70	1.50	0.54	1.06	18.0	14.8	1.26
Rangpur	7.2	1.09	0.19	4.37	1.10	0.06	60.0	2.00	0.73	1.55	248.6	12.7	0.71
Lalmonirhat	5.4	2.11	0.34	0.92	0.25	0.12	62.9	3.33	0.28	0.36	137.3	9.6	2.86
Dinajpur	7.1	1.77	1.88	39.10	7.10	0.10	68.6	1.80	0.55	0.86	163.6	45.6	4.84
Thakurgaon	6.5	0.85	0.61	3.20	1.03	0.05	10.3	16.20	0.41	1.25	45.2	17.7	0.52
Panchagarh	6.6	1.71	0.57	33.70	1.83	0.10	20.0	1.50	0.53	0.44	53.4	4.0	0.61
Gaibandha	6.5	1.62	0.11	8.07	2.42	0.09	55.8	7.00	0.43	1.78	190.9	30.6	2.71
Rajshahi	8.1	1.33	0.17	42.90	1.01	0.08	10.0	9.10	0.70	2.67	15.6	6.0	2.95
Naogaon	7.0	1.29	0.62	5.15	1.65	0.08	26.6	1.90	0.58	1.18	91.0	18.6	1.85
Pabna	7.8	2.42	0.40	5.04	1.57	0.14	116.2	57.40	1.07	4.06	86.8	36.9	10.81
Gazipur	6.4	2.73	0.11	7.78	1.89	0.16	13.6	1.61	0.39	1.04	146.7	36.6	8.31
Narshingdi	8.5	0.52	0.10	12.10	0.66	0.03	28.4	28.67	0.52	1.98	24.2	6.8	0.87
Sherpur	6.8	1.55	0.29	5.00	1.98	0.09	67.4	1.44	0.88	1.88	130.2	12.4	1.48
Mymensingh	7.8	1.33	0.24	10.11	2.90	0.08	27.4	23.43	0.41	0.26	87.1	16.9	2.19
Khulna	7.5	2.70	0.53	17.99	5.50	0.16	17.8	33.85	0.52	0.80	59.9	30.0	0.94
Jessore	8.2	0.49	0.10	26.70	4.20	0.03	12.1	5.20	0.73	0.48	12.3	5.6	1.03
Jhenaidah	8.0	1.20	0.30	17.84	2.98	0.07	26.8	2.45	0.38	1.94	18.9	14.0	1.00
Faridpur	7.9	2.43	0.12	5.33	2.34	0.14	21.3	2.00	0.95	1.78	41.6	9.2	10.60
Shariatpur	8.4	1.25	0.28	22.37	2.76	0.07	16.4	5.26	0.29	2.68	31.0	7.5	0.43
Barguna	7.8	0.69	0.62	5.07	1.62	0.04	17.0	41.40	0.70	1.39	40.4	12.6	0.55

OM = Organic matter, K= Potassium, Ca= Calcium, Mg = Magnesium, P = Phosphorus, S = Sulfur, B = Boron, Cu = Copper, Fe = Iron, Mn = Manganese, Zn = Zinc.

Table 10b. Magnitude of physicochemical properties of soil obtained through soil analysis of 19 habitats in Bangladesh.

Soil of different district	P^H	OM (%)	K	Ca	Mg	Total nitrogen (%)	P	S	B	Cu	Fe	Mn	Zn
			C mol (+)/kg				Microgram/gm						
IBSc Field	Alkaline	Low	Low	VH	High	Low	Low	VL	Opt.	VH	VH	VH	Med.
Rangpur	Neutral	Low	Med.	Med.	Med.	VL	VH	VL	High	VH	VH	VH	Low
Lalmonirhat	Acidic	Med.	Opt.	VL	VL	Low	VH	VL	Low	Med.	VH	VH	VH
Dinajpur	Neutral	Low	VH	VH	VH	Low	VH	VL	Opt.	VH	VH	VH	VH
Thakurgaon	Acidic	VL	VH	Med.	Med	VL	Low	Med.	Med.	VH	VH	VH	Low
Panchagarh	Neutral	Low	VH	VH	High	Low	Med.	VL	Opt.	Med.	VH	VH	Low
Gaibandha	Acidic	Low	Low	VH	VH	VL	VH	VL	Med.	VH	VH	VH	VH
Rajshahi	Alkaline	Low	Low	VH	Med	VL	Low	Low	High	VH	VH	VH	VH
Naogaon	Neutral	Low	VH	Opt.	High	VL	Opt.	VL	Opt.	VH	VH	VH	High
Pabna	Alkaline	Med.	High	Opt.	High	Low	VH	VH	VH	VH	VH	VH	VH
Gazipur	Acidic	Med.	Low	VH	VH	Low	Low	VL	Med.	VH	VH	VH	VH
Narshingdi	Alkaline	VL	Low	VH	Low	VL	Opt.	Opt.	Opt.	VH	VH	VH	Low
Sherpur	Neutral	Low	Opt.	Opt.	VH	VL	VH	VL	VH	VH	VH	VH	Opt.
Mymensingh	Alkaline	Low	Med.	VH	VH	VL	Opt.	Opt.	Med.	Low	VH	VH	High
Khulna	Alkaline	Med.	VH	VH	VH	Low	Med.	High	Opt.	VH	VH	VH	Med.
Jessore	Alkaline	VL	Low	VH	VH	VL	Low	VL	High	Opt.	High	VH	Med.
Jhenaidah	Alkaline	Low	Opt.	VH	VH	VL	Opt.	VL	Med.	VH	VH	VH	Med.
Faridpur	Alkaline	Med.	Low	Opt.	VH	Low	Med.	VL	VH	VH	VH	VH	VH
Shariatpur	Alkaline	Low	Opt.	VH	VH	VL	Med.	VL	Low	VH	VH	VH	VL
Barguna	Alkaline	V L	VH	Opt.	High	VL	Med.	VH	High	VH	VH	VH	Low

OM = Organic matter, K = Potassium, Ca = Calcium, Mg = Magnesium, P = Phosphorus, S = Sulfur, B = Boron, Cu = Copper, Fe = Iron, Mn = Manganese, Zn = Zinc, Opt.= Optimum, Med.= Medium, VH = Very High, VL = Very Low.

Plants are greatly restricted in growth field under stress conditions, and have evolved many mechanisms to rapidly adapt to drought stress condition to keep growth and productivity (Zhu, 2002). The experimentation field of the present study belongs to semi-drought condition and the soil is highly alkaline, while the organic matter, potassium, total nitrogen and phosphorus are very low. In response to these conditions *C. dactylon* accessions collected from different regions of Bangladesh were found to be adapted very soon and nicely.

Table 11. Interpretation of soil test values based on critical limits (loamy soil for upland crops).

Nutrient Element	Very low	Low	Medium	Optimum	High	Very high
N%	≤0.09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
P (µg/g soil) (Olsen method)	≤7.50	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
S (µg/g) soil	≤7.50	7.51-15.0	15.1-22.5	22.51-30	30.1-37.5	>37.5
K (meq/100g)	≤0.09	0.091-0.18	0.181-0.27	0.271-0.36	0.361-0.45	>0.45
Ca (meq/100g)	≤1.50	1.51-3.0	3.1-4.5	4.51-6.0	6.1-7.5	>7.5
Mg (meq/100g)	≤0.375	0.376-0.75	0.751-1.125	1.126-1.5	1.51-1.875	>1.875
Cu (µg/g)	≤0.15	0.015-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75
Zn (µg/g)	≤0.45	0.451-0.9	0.91-1.35	1.351-1.8	1.81-2.25	>2.25
Fe (µg/g)	≤3.0	3.1-6.0	6.1-9.0	9.1-12.0	12.1-15.0	>15.0
Mn (µg/g)	≤0.75	0.756-1.5	1.51-2.252	2.256-3.0	3.1-3.75	>3.75
B (µg/g)	≤0.15	0.151-0.3	0.31-0.45	0.451-0.6	0.61-0.75	>0.75

Ref. Fertilization Recommendation Guide.

This might be due to such mechanism as physiological, biochemical, molecular and cellular changes to cope with limited water supply (Xu and Huang, 2010; Lue et. al., 2011). Infact after transplanting the different accessions of this grass species each block was irrigated in limited way. Comparatively *C. dactylon* is one of the most drought tolerant turfgrasses (Kim et. al., 2009; Zhao *et. al.,* 2011). Some studies have suggested that drought tolerance of *C.dactylon* might be correlated with plant development such as leaf firing, root and shoot systems, and mass production (Carrow, 1996; Huang et. al.1997a; 1997b; Qian *et al.*, 1997), accumulation of dehydrin (Hu *et al.*, 2010a; Cambell and Close, 1997), evapotranspiration (Carrow, 1995), leaf water content, chlorophyll content, proline content and antioxidant enzyme activities (Hu *et al.*, 2010b; Lu *et al.*, 2007, 2009).

In the present study, shoot character consisting of seven parameters showed variations among 19 accessions both significantly and nonsignificantly. Number of shoots, shoot length and shoot fresh weight revealed significant variation. Almost similar results were found in case of root characters. Here number of root and number of rhizomes were found to show significant variations among the said accessions. Gobilik *et al.* (2013) studied five ecotypes of *C. dactylon* and in his general assessment, the Beaufort ecotype was found with shorter shoot length and the Sipitang ecotype had a higher shoot number.In addition, the Beaufort ecotype had higher shoot dry weight in salt treatment and on the contrary, Sipitang ecotype had higher shoot fresh weight. Salt causes roots to experience negative osmosis, distorts root nutrients uptake and impedes plant growth (Hajibagheri, 1989). The soil of the experimentation field was highly alkaline and that might be the cause of non-significant variation of root length, root fresh weight and root dry weight. Gobilik *et al.* (2013) found also all the five ecotypes with similar root fresh weight. Another important character of root i.e., number of rhizomes showed significant variation among the accessions. Dong and de Kroon (1994) stated that *C. dactylon* does not form rhizomes under shaded conditions.

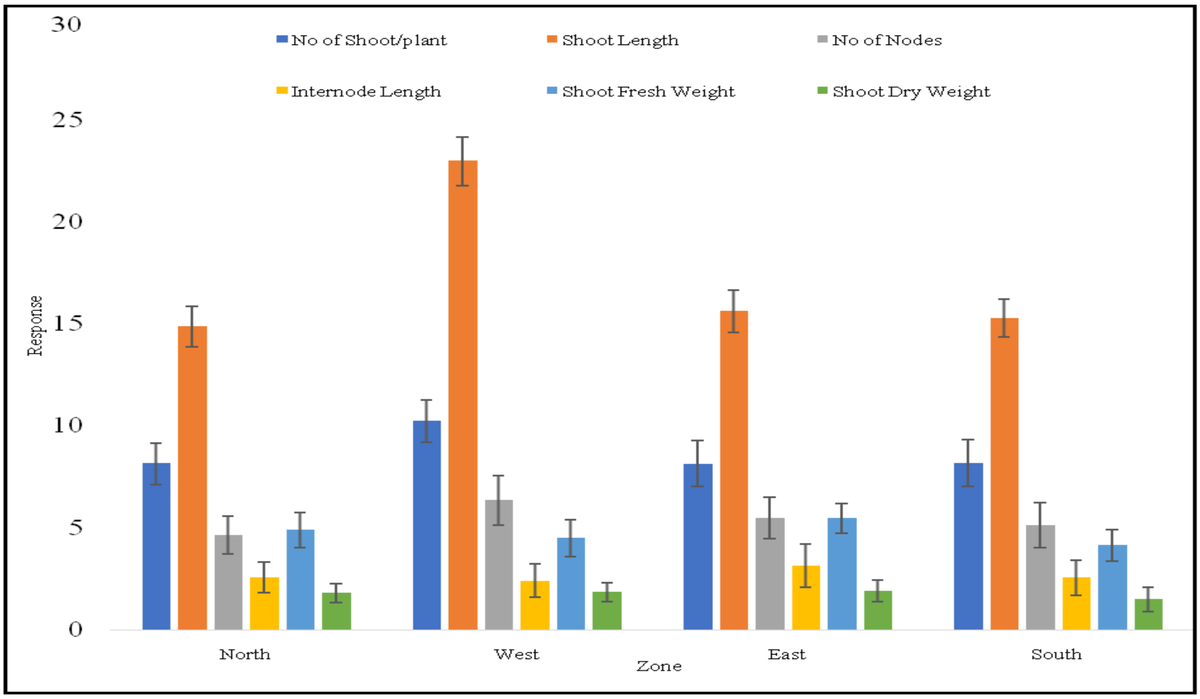

Fig. 1. Morphological variation of shoot of *Cynodon dactylon* in different zone of Bangladesh.

The present experimentation field was very much ambient and under high intensity of sun light. Even then this character showed wide variation.

However, Van De Wouw *et al.* (2009) stated that the presence of rhizomes in *C. dactylon* is the only identifying character compared to that of other *Cynodon* species. In case of leaf characters only number of leaf and total leaf area were found to show significant variations among the accessions studied in the present study. Other four characters showed no variations statistically.

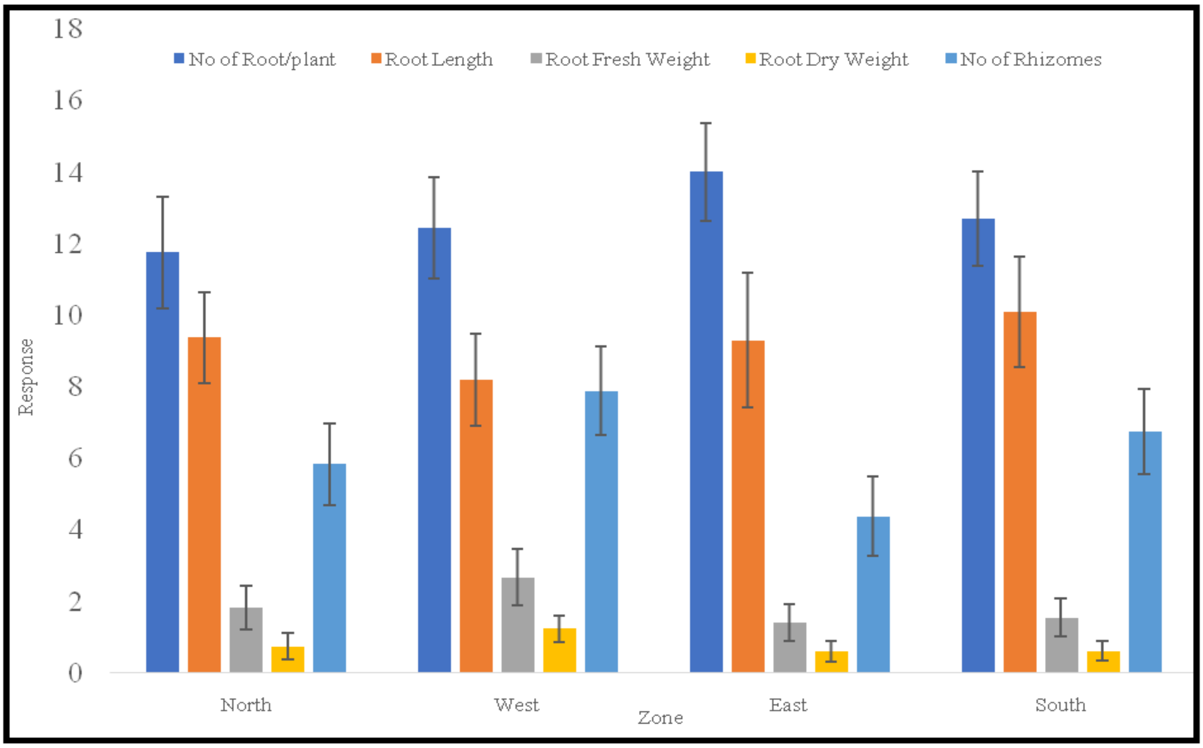

Fig. 2. Morphological variation of root of *Cynodon dactylon* in different zone of Bangladesh.

This also might be due to the salt accumulation in mature leaves which damages leaf tissues and decreases leaf photosynthetic activity (Gobilik *et al.* 2013). Hussain *et al.* (2012) stated that negative osmosis causes mesophyll turgidity loss and partial stomata opening reducing total leaf CO_2assimination per day. In saline soil, plants may die when new leaf formation cannot match leaf death or produce sufficient energy for plants (Munns and Termaat,1986).However, it is not expected in case of *C. dactylon* always, because this grass species can increase its root mass when salt concentration rises until it reaches a peak before starts to decline(Dudek *etal.*,1983). Probably same sorts of mechanism worked for maximum plant height, which was found with significant variation among all the plant accessions. Van De Wouw *et al.* (2009) found considerable diversity of plant height in a large group of accessions of *C. dactylon* and *C. nlemfuensis*.

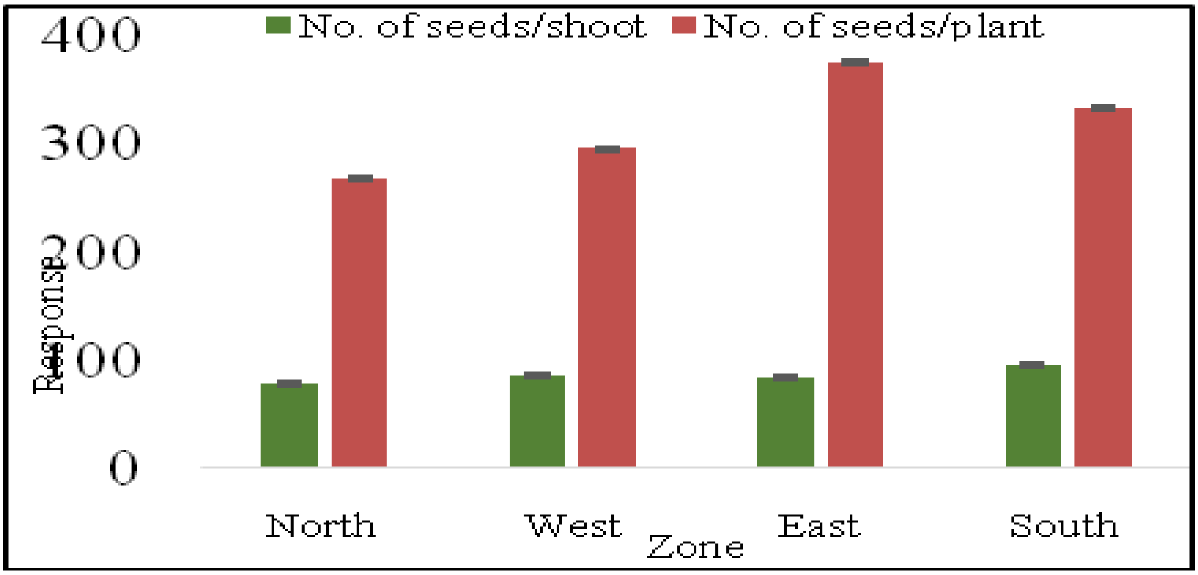

Fig. 3. Morphological variation of flower of *Cynodon dactylon* in different zone of Bangladesh.

The horizontally growing aboveground part of *C. dactylon* stems, called stolon were found to show non-significant variations in the present study. Van De Wouw *et al.* (2009) found 98 accessions of *Cynodon* belonging four different species with stolons, with considerable variation in number and length, and they stated that this might be due to very plastic response of stolons to light intensity and nutrient availability. Their findings support the present findings in all the 19 accessions of *C. dactylon*.

In *C. dactylon*, flowering stems are upright and bear a terminal group of 3-7 spikelike branches, originating in a single whorl on the tip of the stem. The colour of the spikelet was found to show somewhat variation of the main colour brown. In the same accession the spikelets were not purely brown, rather it was found with light green or green. Nasiri *et al.* (2012) described inflorescence of this grass species to be raceme like panicle and spikes to be glabrous, elongated and green to purple green, or green withpurple spots and yellowish at maturity. However, the ANOVA analysis in the present study showed no significant variation in case of inflorescence number and length of racemes. But the seed characters like seeds number per shoot and seeds number per plant were found with statistical variation. There are two types of *C. dactylon* and they are namely common and giant. Both these types are seeded varieties and they correspond to a wide range of genotypes and they are selected for their adaptability to different cultivation conditions (Ball and Pinkerton, 2002).

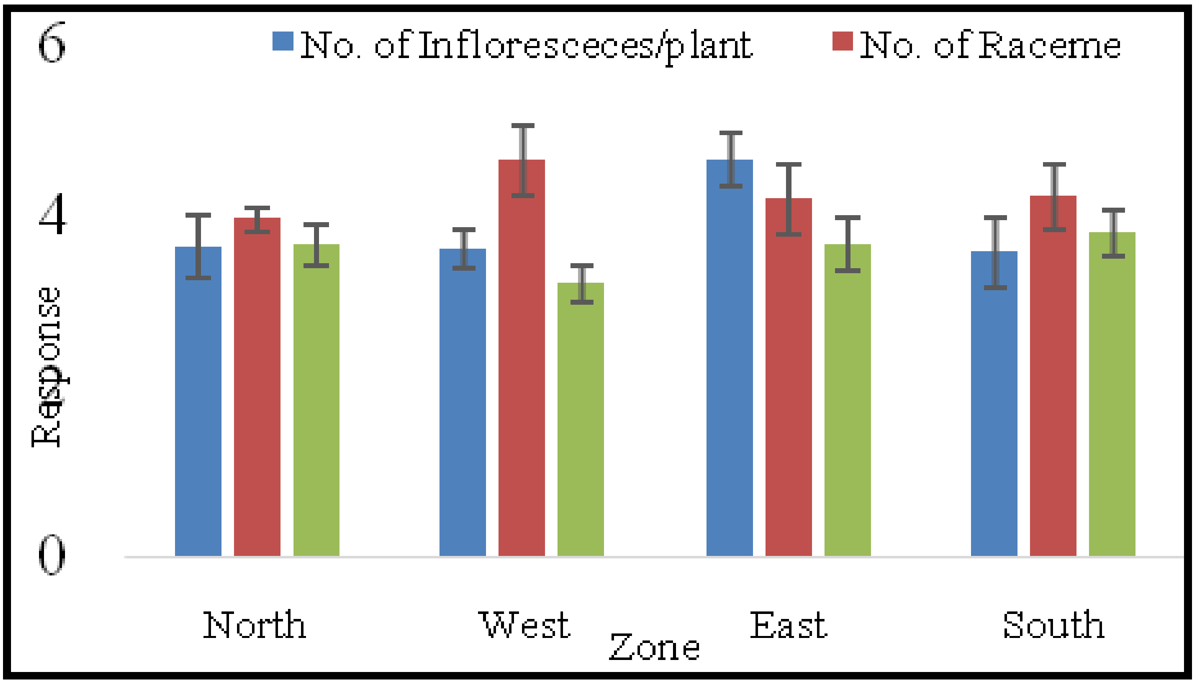

Fig. 4. Morphological variation of seed of Cynodon dactylon in different zone of Bangladesh.

In some were, "common" has become synonymous with any seed propagated Bermuda grass (Busey, 1989). Seeded varieties are outstanding tolerant of drought and heavy grazing. All the 19 accessions of *C. dactylon* in the present study were found to be seeded and since they are showing significant variation in respect of their number per shoot and per plant, their seeds may be commonly mixed for making commercial blend. Juska and Hanson (1964) stated that Bermuda grass (*C. dactylon*) vary with respect tothis characteristics of seed heads, when they appear and how long they persist. Some accessions have seed heads from early in the growing season throughout much of the summer, whereas with others seed heads may persist for a relatively short time.

They also mentioned that genetic factors and day length affect seed head formation. Seed characters found in 19 accessions of the present study might be due to these two regions in relation to their different habitats, Mc Whorter (1971) found extreme variability between ecotypes of Jhonson grass (*Sorghum halepense*(L.)Pers.) in seed production, shattering characteristics and in size and appearance of panicles. Seed of all ecotypes occurred in all spikelets clustered on short racemose branchlets. This type of mechanism may also be applicable in case of Bermuda grass. However, Al-Juboory and Hassaway (1980) stated that the differences that occur in the morphological development of Cogongrass (*Imperata cylindrica*) collected throughout Iraq and grown under the same condition, give another indication that the ecotypes represent various stages of evolutionary differentiation more than just local population.

They further said that this may be due to the process of sorting and controlling environmental factors (habitat factors) on species population which differ genetically. Their statement fully supports the finding in case of morphological variation of 19 accessions of *C. dactylon* in the present study.

The soil of the present experimentation field was found to be alkaline and the organic matter was low. Total nitrogen, potassium and phosphorus were also low. Other nutrients were somewhat favourable. The soil texture of the experimentation field was found to be clay loam under agroecological zone 26.In such a condition 19 accessions from different habitats belonging to four different zones were planted to find out their morphological variations along with adaptation. Almost under different conditions Ramakishnan and Gupta(1973) conducted an experiment with differential response of nitrogen, phosphorus and potassium. In conclusion they have said that besides calcium which was shown to be partially responsible for the restriction of three ecotypes of *C. dactylon* to their respective habitats, the availability of nitrogen, potassium and also phosphorus may play an important role. But striking all the accessions of *C. dactylon* in the present study showed no such poor performance comparatively among them and they were found to be well adapted.

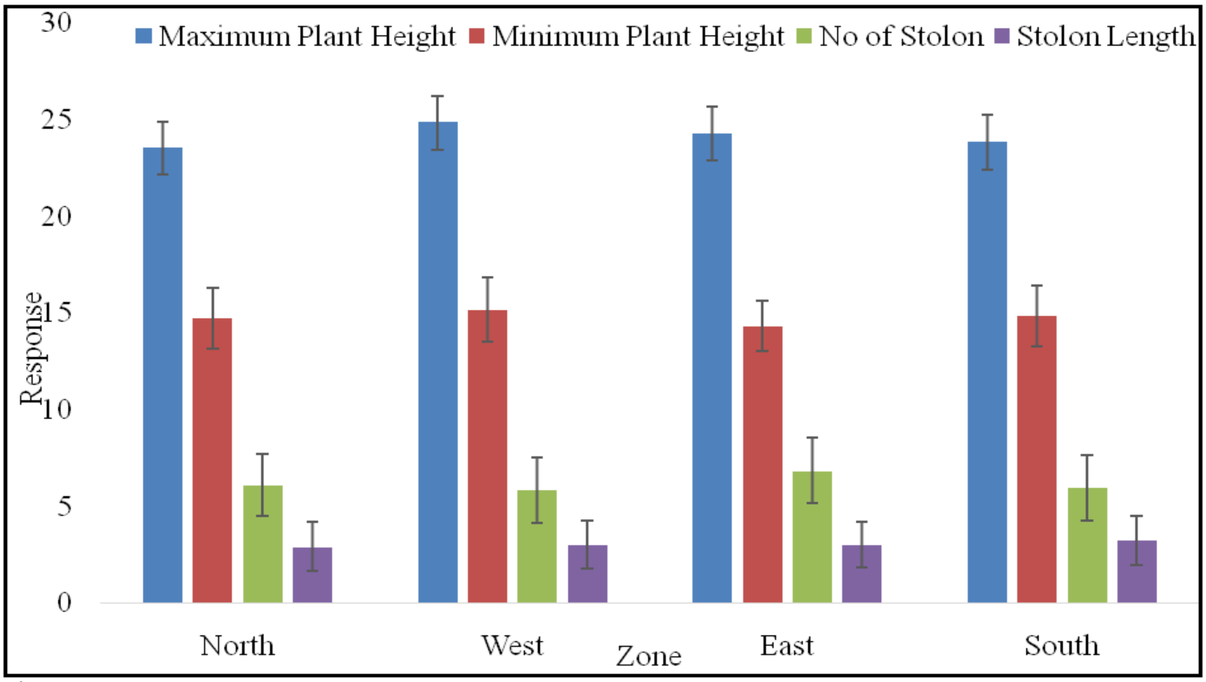

Fig. 5. Morphological variation of plant height and stolon of *Cynodon dactylon* in different zone of Bangladesh.

In most of the soils of different habitats in the present study organic matters and nitrogen were very low or low. At the same time Calcium and Magnesium were very high and high, respectively in the experimentation field. Calcium was found to be available in soils of different habitats. Only magnesium was low in the soil of Narshingdi. It is evident now that the macronutrients such as N,P,K^+ and Ca^{2+} are essentially required for regulation of a multitude of phenomena such as the activities of enzymes, protein synthesis, integrity of cell wall and plasma membrane, and as components of proteins, photosynthetic protein complexes, photosynthetic pigments, RNA and DNA(Taiz and Zeiger,2002; Akram *et al.*, 2008).Potassium in plants in the form of cation(K+) plays a vital role in regulation of osmotic adjustment by lowering osmotic potential of cells (Akram *et al.*,2008). It has been reported by Premachandra *etal.*(1990)that water stress generally increase the K^+ concentration especially under low phosphorus levels. Similar situation might be occurred in the present study where water supply was very much limited and phosphorus levels were low or medium in 7 soils of the habitat. In the present study, phosphorus concentrations were high in most of the soils of different habitats and that might be the cause of reduction in shoot and root characters. Very high and optimum level of Ca caused promising shoot character but low level of nitrogen was not favorable for shoot characters, particularly in case of minimum water supply in case of all the accessions of *C. dactylon*. In the case of few other micronutrients, sulfur was found to be low, while availability of Zinc was somewhat better in soils of different habitats in the present study. On the contrary the amount of copper, iron and manganese were sufficient almost in all the habitats.

Its now evident that the most reliable micronutrients for healthy plants are zinc, boron, copper and manganese. These are used by plants in small quantities. Inspite of the low requirement, critical plant functions are limited if micronutrients are unavailable resulting many plant abnormalities.

However, sandy soils with low organic matter may contain deficient micronutrients. High pH soils may make some nutrients low. Cations of copper, iron, manganese and zinc may hep to the soil properties, and solubility becomes high under acid condition and becomes deficient on calcareous soils or becomes high in organic matter where strong chelation decreases availability (Meugel, 1990; Bennett, 1993; Stevans *et al.*, 2002; Kelling, 2005).

All the 19 accessions of *C. dactylon* collected from different habitats and transplanted in an alkaline soil of the experimentation field were found to be adapted nicely inspite of their different physico-chemical and environmental conditions. That might due to many physiological and biochemical mechanisms to any environmental conditions keeping their growth and productivity more or less properly.

Several studies report nutrient data for warm season turfgrass including bermuda grass (*C. dactylon*) in many transition zones in the world (Wu *et al.*,2009).Mineral composition of bermudagrass was studied by McCrimmon (2001), Snyder and Cisar (2000) and Walworth and Kopec (2004) with different results depending on the cultivar and different nutrient sources and rates. Volterrani *et al.* (2012) stated that use of plug plants shows several advantages and this technique is useful for noninvasive putting green conversion, since the use of fully developed root systems and actively growing shoots enhances their colonization potential. These features also might be the appropriate reason for proper growth and adaptation of different accession of 19 different habitats in this experiment.

Conclusion

The present research study was of academic interest particularly in relation to adaptation of *Cynodon dactylon* accessions collected from four different zones of Bangladesh. A total of nineteen accessions were evaluated agro-morphologically and they showed variability as far as the quantitative parameters were concerned. Most of the collected germplasms were found to be susceptible to the weather and alkaline clay soil of the experimentation field. Observations from this study indicate both significant and non-significant variations among the accessions in terms of vegetative and reproductive characters. Rhizomatous and stoloniferous nature showed both maximum and minimum growth variation. Soil properties of their habitat were found to be somewhat different in many cases compared to that of the experimentation field. But at the same time all the accessions were found to be well adapted to the soil of experimentation field which indicates the functional qualities like rigidity, resiliency, elasticity, rooting capacity etc. of this grass species. All the end, it may be said that further studies are needed for better characterization of *C. dactylon* in order to assess the potential benefits compared that of other alike grass species.

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