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Salinity stress on morphological and nutritional quality of Napier cultivars under hydroponic condition

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Abstract

The study was conducted to determine the effect of salinity stress on morphological and nutritional quality of Napier cultivars in terms of biomass yield, tiller numbers, leaf number, tiller height, shoot presence or absence per cutting, leaf condition, dry matter (DM) and crud protein (CP) content under hydroponic condition. four Napier cultivars such as BLRI Napier-1, BLRI Napier-2, BLRI Napier-3 and BLRI Napier-4 were cultivated under hydroponic system developed by Bangladesh Agricultural Research Institute (BARI) with some modifications. All the selected cultivars were grown by using BARI standard hydroponic solution. Five salinity levels were considered as treatments such as 3, 4, 5, 6 and 7 dS m^{-1} using different NaCl concentrations corresponding to the nutrient solution which were noted as T_1 to T_5 and T_0 was used as control where salinity level was 2.3 dSm^{-1}. Four Napier cultivars were grown with 4 replications under each salinity condition and all the treatments were arranged in a Randomized Complete Block (RCB) design. Shoot presence or absence per cutting and leaf condition were determined weekly. The results revealed that the biomass yield, number of tillers, leaf numbers, tiller height, shoot presence or absence per cutting, leaf condition, and DM and CP content among all the cultivars were decreased linearly with the increased of salinity levels. On the basis of different morphological and nutritional parameters, tolerance level of different cultivars of Napier grass to salinity stress can be rated as: BLRI Napier-4>BLRI Napier-3 > BLRI Napier-2 >BLRI Napier-1. Further study need to determine the suitability for large scale adaptation under on-farm conditions.

Key words: salt stress, biomass yield, tiller number, tiller height, leaf number, nutritional quality

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Introduction

Feed shortage is the major reason for low productivity of livestock in Bangladesh especially in coastal area where farmers are extremely challenged with the salinity. The domestic animals mainly survive on common local grasses. More than 93% famers fed paddy straw to their cattle. Cut and carry of natural grasses are common in the coastal area that is not available throughout the year. Livestock production systems have been suffering from lack of feeds and fodder in saline areas. Presently, slight to strong soil salinity problems exist in 20 districts. Salinity intrusion increased by 27 % from 1973 to 2009 (SRDI, 2010). Out of 32% (2.86 M ha) coastal land, 1.056 M ha lands are affected by different degrees of salinity (BARC, 2013). Over 40 million people (28% percent of the total) live in the coastal area. Sea level rise will cause salinity intrusion through rivers and estuaries.

In the rainy season saline water ingress to 10 % of country's area, in the dry season it reaches to 40 % area even. 0.5 meter sea level rise will cause saline water intrusion in many fresh water areas land under threat of salt water inundation loss of livelihoods of 40 million people, 20 million might need relocation by 2050. The distributions of the saline areas in four of the thirty AEZs of the country (the Ganges Tidal Floodplains; AEZ-13, the New Maghna Estuarine Floodplains; AEZ-18, the Chittagong Coastal Plains; AEZ-23 and St Martin's Coral Island; AEZ-24). Crop yields, cropping intensity, production levels and quality of livelihood of the peoples are much lower in this region than other parts of the country (Banglapedia, 2014). At the same time, food demand in the area is increasing with the steady increase in human population. There is debate on the exact size of the current deficit of feed, there is general agreement that the volume and quality of feed and fodder supplies will be vital importance in sustaining the growth of livestock

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sector. The animals of the country mainly depend on rice straw for their nutrition and its contribution to livestock feeds is more than 90% of feed energy for ruminant's diet (Huque and Sarker, 2013). The pattern of deficit varies in different parts of the country. For instance, the green fodder availability in Milk pocket areas and small scale dairy producing areas are little compared to other parts of the country. The availability of straw is more than that of our requirements but the availability to the animals is still deficit upto 30-40% in terms of DM due to the improper storage and harvesting facilities during monsoon. Farmers are habituated to feed their animals largely with straw without having much cultivation of fodder. Currently, only 3290 acres lands are under fodder cultivation. A micro study shows that only 2 per cent of the farmers cultivated HYV fodder and the area devoted to fodder cultivation per farm was 0.002 acre only (Alam, 2006).

Livestock development is mainly depending upon the improvement of animal nutrition through improved feeding and availability of fodder (Preston *et al*., 1987). In this situation, it is of prime consideration to introduce suitable high yielding varieties of perennial fodder crops to the farmers (Ali *et al*., 1987). On a straw-based diet, supplementation of small amount of green grass is often recommended for optimization of rumen environment or even to meet the maintenance requirement of animal (Ranjhan *et al*., 1993).

The environment of Bangladesh is suitable for Napier cultivation. Because Napier grass is i. most popular perennial fodder, ii. recommended for smallholder crop-livestock farming systems, iii. can withstand repeated cutting and regrows rapidly, iv. can be easily cultivated in our local climate, v. requires low water supply, zero nurturing, vi. can be harvested 5 to 6 times per annum, vii. can easily be grown in fallow land, viii. producing a high biomass, ix. very palatable in the leafy stage, x. can be made silage for feeding during the dry season, xi. can also be used for soil regeneration and mulching, and xii. produces more dry matter per unit area than other grasses or legumes. As Napier grass is an important fodder in Bangladesh, extensive research is necessary to develop growing conditions in moderate salinity to produce good vegetative growth. However, a few studies were done on the effect of salinity stress on growth, yield and quality of Napier grass.

In natural conditions, soil acts as a mineral nutrient reservoir but the soil itself is not essential to plant growth. When the mineral nutrients in the soil are dissolved in water, plant roots are able to absorb them. Almost any terrestrial plant can grow like this. This method of growing plants using mineral nutrient solutions, in water, without soil is known as hydroponics. The objectives of this study were to find the most salinity tolerant cultivar(s) of Napier grass for optimum growth/development and performance under various salinity stress levels, and recommendation of the tolerant cultivar(s) to the stakeholder for cultivation and propagation.

Materials and Methods

BLRI Napier-1, BLRI Napier-2, BLRI Napier-3 and BLRI Napier-4 were evaluated for their salt tolerance in a hydroponics system using BARI standard protocol. The experiment was laid out in Completely Randomized Design (CRD) with four replications. Salinity levels were accounted at 3, 4, 5, 6 and 7 dSm^{-1} using different NaCl concentrations corresponding to the nutrient solution which were noted as T_1-T_5 and T_0 was used as control where salinity level was 2.3 $dS\ m^{-1}$. The cork sheets were placed on water in 3 ft x 7ft water tanks made in steel plate. Every cork sheet was consisted of ten holes. Proper aeration of the culture solution was provided for 5 minutes daily with the help of bamboo stick by hand stirring. At two nodes cutting of uniform size were planted in the holes of cork sheets floating over nutrient solution. To prepare 1000 litres nutrient solution, the following amount of chemicals/salts were added with 1000 L of tap water: 270 g of Potassium di hydrogen phosphate (KH_2PO_4); 580 g of Potassium nitrate (KNO_3); 1000 g of Nitro calcite[$Ca(NO_3)_2{\cdot}4H_2O$]; 510 g of Epsom salt ($MgSO_4{\cdot}7H_2O$); 80 g of EDTA Iron (NaFe-EDTA); 6.10 g of Manganese Sulfate($MnSO_4.4H_2O$); 1.80 g of Boric acid (H_3BO_3); 0.40 g of Blue vitriol ($CuSO_4{\cdot}5H_2O$); 0.38 g of Ammonium hepta molybdate [$(NH_4)_6Mo_7O_{24}.4H_2O$]; 0.44 g of White vitriol ($ZnSO_4{\cdot}7H_2O$). From each cultivar two cuttings were considered as one replication. Cork sheet was used on the water tank to hold the cutting in the nutrient solutions. Electrical Conductivity Meter (EC meter) was used to measure the salinity of the nutrient solution. The pH of the solution was monitored daily and adjusted at 6.0±0.5, when needed. The cuttings were allowed to grow in this condition for forty days. Livestock sector is producing only 30.18% of national requirements of meat. The per capita intake of meat is only 8.6 kg in Bangladesh against 42.1 kg and 32.2 kg for world and developing countries, respectively (Huque, 2012). To meet this gap, meat production of the country must be increased many folds. On the other hand, beef is a very popular meat item to the Bangladeshi consumers. But beef price is increasing tremendously especially in the last 12 years. Bangladesh has been facing demand and supply mismatches of beef due to insufficient production and supply, low carcass yield of native cattle and recent no-cattle export policy of a long bordered neighboring country. According to last Agricultural Census 2008, Bangladesh had very high density of cattle which was about 188 head/km^2 (Huque and Khan, 2017). Bangladesh has little opportunity to increase cattle population instead of increasing productivity. Thus, Bangladesh has taken an opportunity for boosting its bovine industry through on-going program like cattle fattening and crossbreeding for dairy and beef cattle production. Our country has only native cattle which grow at a slower rate than most of the temperate fast growing beef breeds. Study showed that cattle in a feedlot system showed the value of feed conversion ratio (FCR) ranges from 5.93 to 10.10 whereas, a BCB-1 bull of 250 kg live weight gained 1200g/day and showed 5.13 to 6.73 FCR (Huque, 2011) which indicates that BCB-1 may has lower body weight at mature age compared to most temperate beef breeds but still they are more promising for beef production as FCR is an important economic parameter for commercial beef production. But, in order to support the increasing demand of beef we need to produce fast growing beef cattle within an economic FCR. Following the consequence DLS (Department of Livestock Services) has taken a breeding program for beef production. Imported frozen semen of American Brahman bulls has been inseminating in native cattle of Bangladesh to produce crossbred beef cattle. But before starting this program, no research has been done to compare the performances of Brahman crossbred with other crossbred exotic beef genotypes and native in the existing environment and similar feeding management system.

On the other hand, the dam line, which used in Brahman crossbred production, was not from similar breed which caused difficulties in evaluation of heterosis effect. In the recent studies of BLRI and DLS reported that Brahman crossbred bulls showed the higher FCR (12.1) compared to native BCB-1 (9.5) or Red Chittagong Cattle (9.9) (Roy *et al*., 2013; Rashid *et al.,* 2014). Considering the facts, the present work was undertaken to evaluate comparative performance of different crossbred beef genotypes. Here, three exotic beef breed i.e. Simmental, Charolais and Limousin alone with American Brahman was used as sire line on a single dam line BCB-1for the production of crossbred progeny. Simmental, Charolais, Limousin and American Brahman are worldwide recognized beef cattle breed and BCB-1 is a native cattle developed through selective breeding of native cattle named 'Pabna' evolved through admixture of Hariana, Tharparker and Sahiwal genetic materials (Bhuiyan *et al.,* 2007). The coat color and body size of BCB-1 bulls are attractive which have a great market value as a meat type cattle. Thus, the objective of the present work was to develop market beef cattle of average >150 Kg carcass weight by 24 months at an average FCR of <6.50 under similar feeding management conditions.

Results and Discussion

The biomass yield was decreased significantly with the increasing levels of salinity. The highest biomass yield was obtained with the control, T_1 & T_2 and lowest was T_3, T_4 and T_5. Moreover, BLRI Napier-4 and BLRI Napier-3 showed better performance than BLRI Napier-1and BLRI Napier-2 in terms of biomass yield (Table 1). Significant variation was found with different level of salinity in tiller number counting. Tiller number decreased with the increasing salinity levels. The highest tiller numbers were showed in control, T_1, and T_2, while gradually the lowest tiller number were recorded at T_3 to T_5 (Table 2). However, the leaf numbers per tiller was significantly affected by different salinity levels in BLRI Napier-3 and BLRI Napier-2. The control, T_1, and T_2 EC gave the highest values of leaf number. Whereas, high salinity level i.e.T_3 to T_5 EC treatment were provided the lowest values of leaf number (Table 3). Significantly variation was exhibited with tiller height (inch) by different salinity levels in BLRI Napier-3 and BLRI Napier-2. No significant variation was exhibited with tiller height by different salinity levels in BLRI Napier-4 and BLRI Napier-1.

Table 1. Biomass Yield (gm) at different dSm^{-1}

Variety	Biomass Yield (gm)at different salinity levels						Sig.
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	410.50±220.07^{a}	373.50±87.87^{a}	286.00±22.75^{b}	158.00±53.84^{b}	90.25±36.00^{b}	81.00±29.14^{b}	*
BN-4	644.00±252.61^{a}	524.50±103.20^{a}	509.50±47.80^{a}	268.00±97.29^{b}	212.25±84.69^{b}	129.75±65.14^{c}	*
BN-1	393.50±102.90^{a}	163.25±82.74^{b}	96.50±63.97^{b}	13.50±13.50^{c}	14.75±9.92^{c}	10.00±10.00^{c}	**
BN-2	390.00±140.13^{a}	291.00±176.98^{b}	260.50±37.05^{b}	91.25±52.58^{bc}	69.75±10.58^{bc}	31.50±11.50^{c}	*

N.B. BN, BLRI Napier; dsm^{-1}, dissolved solids per meter area. Different superscripts a, b, and c indicate significant differences within rows; ($p<0.05$), *significant at 5% level; **-significant at 1% level ($P<0.01$).

Table 2. Tiller numbers at different dSm^{-1}

Variety	Tiller number at						Sig.
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	18.50±1.75^{a}	10.25±4.93^{b}	10.25±1.70^{b}	10.00±0.91^{b}	6.75±1.88^{b}	6.00±0.40^{b}	*
BN-4	19.75±0.75^{a}	17.0±1.77^{ab}	13.50±6.30^{ab}	10.25±2.05^{ab}	7.50±2.86^{b}	6.75±2.78^{b}	*
BN-1	11.25±1.49^{a}	9.75±3.22^{ab}	6.25±3.61^{ab}	2.75±1.88^{b}	2.75±1.88^{b}	2.50±1.65^{b}	*
BN-2	15.75±1.93^{a}	14.25±3.92^{a}	9.75±1.54^{b}	9.50±1.44^{b}	5.50±2.21^{c}	3.10±1.88^{c}	*

N.B. BN, BLRI Napier; dsm^{-1}, dissolved solids per meter area. Different superscripts a, b, and c indicate significant differences within rows; ($p<0.05$), *significant at 5% level; **-significant at 1% level ($P<0.01$).

Table 3. Leaf number at different dSm^{-1}

Variety	Leaf number at						Sig.
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	9.15±0.52^{a}	8.36±0.29^{a}	8.26±0.39^{a}	7.92±0.73^{a}	7.68±0.66^{a}	4.88±1.94^{b}	*
BN-4	8.59±0.36	8.34±0.38	8.13±0.24	8.11±0.38	6.04±2.04	5.82±1.96	NS
BN-1	6.90±1.14^{a}	6.36±2.17^{a}	4.06±2.34^{ab}	3.20±1.85^{ab}	2.39±1.56^{b}	1.30±1.30^{c}	*
BN-2	9.35±0.52^{a}	9.01±0.20^{ab}	8.32±0.33^{ab}	6.65±0.41^{bc}	6.62±0.29^{bc}	4.95±1.74^{c}	*

N.B. Different superscripts a, b, and c indicate significant differences within rows; ($p<0.05$), *significant at 5% level; **-significant at 1% level ($P<0.01$); NS, non significant.

The highest tiller height was found in control which was similarly comprised with 3 and 4 dS m^{-1}. Lowest heights were recorded at 5, 6 and 7 dS m^{-1} of salinity levels (Table 4). Shimul *et al.,* (2014) reported that plant growth increased with decreasing salinity level and probably salinity create an unfavorable condition on plant growth, that is why plant height decreases with the increasing level of salinity in present hydroponic culture, as way to plant height increased in control application of salinity. Salinity also showed the same effect that plant height reduced with increasing level of salinity and it reduced elongation rate of the main stem in plant (Tal and Shannon, 1983; Oztekin and Tuzel, 2011). Pessarakli *et al*. (2008) reported that shoot and root lengths and shoot DM weights decreased linearly with increased salinity for Bermuda grass and paspalum.

Table 4. Tiller height (inch) at different dSm^{-1}

Variety	Tiller height (inch) at						Sig.
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	29.36±1.99^{a}	27.61±1.54^{a}	24.65±0.81^{a}	21.66±2.27^{a}	19.56±3.18^{ab}	10.50±6.23^{b}	*
BN-4	26.98±3.73^{a}	26.33±4.23^{a}	25.96±1.07^{a}	23.26±1.18^{a}	19.48±6.52^{ab}	15.16±5.42^{b}	*
BN-1	19.76±7.32^{a}	19.02±4.03^{a}	9.69±5.61^{ab}	7.58±4.37^{ab}	5.37±3.34^{b}	4.25±4.25^{b}	*
BN-2	26.61±1.53^{a}	25.56±1.62^{a}	21.64±1.69^{ab}	17.25±2.08^{b}	16.67±0.44^{b}	14.99±5.17^{b}	*

BN, BLRI Napier; dsm^{-1}, dissolved solids per meter area. Different superscripts a, b, and c indicate significant differences within rows; (p<0.05), *significant at 5% level.

Table 5. Dry matter (DM) % at different $dS\ m^{-1}$

Variety	Dry matter (DM) % at						Sig
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	12.76±0.42^{a}	12.52±0.23^{a}	12.21±0.37^{a}	12.03±0.71^{ab}	10.77±0.48^{bc}	10.09±0.26^{c}	**
BN-4	12.01±0.04^{a}	11.97±0.55^{a}	11.74±0.22^{a}	11.76±0.15^{a}	10.74±0.23^{b}	9.50±0.22^{c}	**
BN-1	12.74±0.12^{a}	12.33±0.25^{a}	11.30±0.36^{b}	10.72±0.24^{b}	10.72±0.51^{b}	9.22±0.09^{c}	**
BN-2	14.19±0.74^{a}	13.54±0.29^{a}	13.71±0.98^{a}	11.40±0.23b	10.77±0.68^{bc}	9.06±0.19^{c}	**

N.B. BN, BLRI Napier; dsm^{-1}, dissolved solids per meter area. Different superscripts a, b, and c indicate significant differences within rows; (p<0.05), *significant at 5% level; **-significant at 1% level (P<0.01).

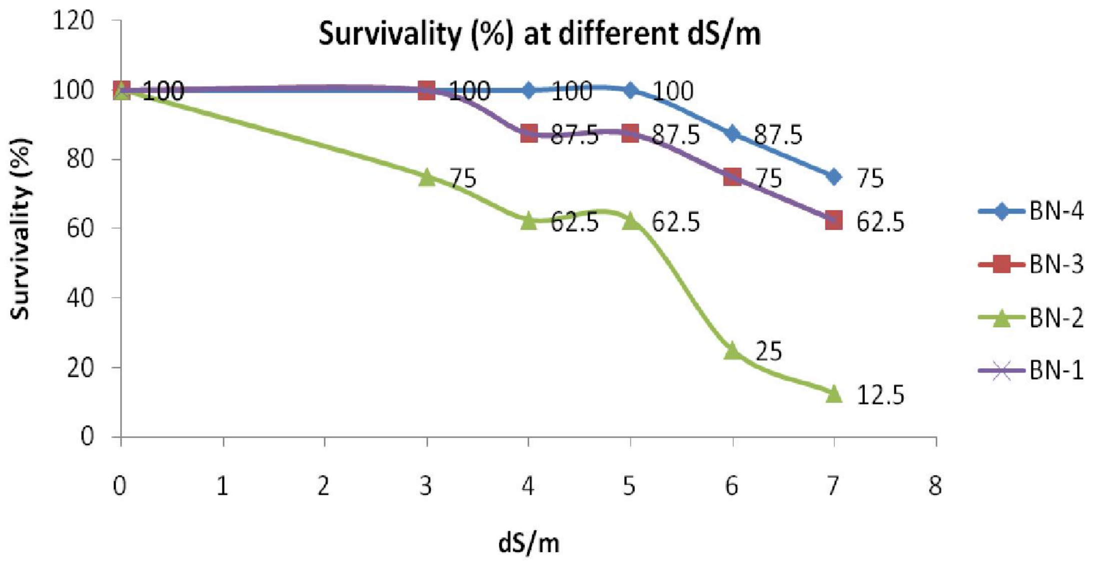
Table 6. Crude Protein (CP) % at different dSm^{-1}

Variety	Crude Protein (CP) % at						Sig
	Control	3 dSm^{-1}	4 dSm^{-1}	5 dSm^{-1}	6 dSm^{-1}	7 dSm^{-1}	
BN-3	20.08±0.28^{a}	18.48±0.59^{b}	18.25±0.48^{b}	17.63±0.43^{ab}	17.56±0.44^{ab}	16.36±0.26^{c}	**
BN-4	21.27±1.11^{a}	19.66±0.75^{ab}	18.23±0.42^{bc}	18.00±0.45^{bc}	17.30±0.32^{c}	16.32±0.27^{c}	**
BN-1	19.80±0.80^{a}	18.54±0.62^{ab}	17.28±0.84^{ab}	17.04±0.86^{ab}	16.68±1.49^{b}	15.94±0.37^{b}	*
BN-2	17.19±1.46	17.78±0.41	17.59±0.35	17.21±0.39	16.81±0.54	16.45±0.21	NS

N.B. BN, BLRI Napier; dsm^{-1}, dissolved solids per meter area. Different superscripts a, b, and c indicate significant differences within rows; (p<0.05), *significant at 5% level; **-significant at 1% level (P<0.01). NS, non significant.

The dry matter contents (%) showed a statistically significant variation for different salinity levels. Dry matter content was increased with the decreased salinity level. Maximum dry matter was obtained with the control and T_3 EC and the lowest (%) were counted at T_5, T_6 and T_7 EC (Table 5). In addition, Significant variation was found with different level of salinity at hydroponic Napier culture for Crude Protein (CP) % in BLRI Napier-1, BLRI Napier-3 and BLRI Napier-4. No significant variation was exhibited with the Crude Protein % by different salinity levels in BLRI Napier-2. The highest Crude Protein % was obtained with the control, where CP % was gradually decreased from the lowest to the highest (3 to 7) dSm^{-1} EC (Table 6).

Figure 1. Surviability (%) at different ds/m



Shoot survivability from each cutting was found variation with different levels of salinity. The highest shoot initiation was obtained in control and T_3 of all cultivars, while gradually shoot initiation decreased were recorded at 5, 6 and 7 EC (Fig-1). Wambua *et al.*, (2010) reported that shoot elongation and dry weight were more sensitive to salinity than root growth, with significant reduction in growth occurring at high salinity levels 10 and 15dS/m in sorghum *(Sorghum bicolor* L. Moench*)*. Nadeem *et al.,* (2012) observed that increasing salt concentration in the nutrient media caused a reduction in number of stolons/plug, number of roots/plug, length of shoot, dry weights of root, shoot and turf quality. This decrease in shoot dry weight could be due to shrinkage of cellular contents, reduced growth, development, and differentiation of tissues and disturbed avoidance mechanism as described earlier in different plant species under salt stress (Kent & Lauchli, 1985; Suplick-ploense *et al.*, 2002; Munns & Tester, 2008). Salinity effects the growth of plants, which reduces metabolite synthesis and ultimately decreases dry weight of shoot (Cheesman, 1988).

Conclusion

The study revealed that the biomass yield and tiller numbers were decreased linearly with the increased of salinity levels for four Napier cultivars. There was no significant differences were observed in leaf number and tiller height of BLRI Napier-4 and BLRI Napier-1 at any level of salinity. The variation was found with different level of salinity in cultivars for CP % except BLRI Napier-2. The highest values of morphological characters and CP % was obtained from the control, where it was gradually decreased from 3 to 7 dSm^{-1} EC. Dry matter (%) was decreased of four Napier cultivars with the increased of salinity levels . Shoot initiations from per cutting cultivar were obtained in control and of all cultivars. On the basis of different morphological and nutritional parameters, tolerance level of different cultivars of Napier grass to salinity stress can be rated as: BLRI Napier-4>BLRI Napier-3>BLRI Napier-2> BLRI Napier-1.

References

Alam J, M Akteruzzaman, SMA Rahman and QM Alam (2006). Economics of triticale production as fodder for dairy animals in Bangladesh. Bang. J. Lives. Res. Vol. 13:1-16.

Ali MS, NM Talukder and Z Karim (1987). Effect of fertilizers, trace elements (Mo,Mn, B) and sulphur on growth characters and quality of German grass. *Bang. J. Anim. Sci. 16: 3742.*

Cheesman JM (1988). Mechanism of salinity tolerance in plants. *Plant Physiol.,* 87: 547-550.

Huque KS and NR Sarker (2013). Feed and feeding of livestock in Bangladesh performance, constraints and options forward. Bangladesh Livestock Research Institute, Savar, Dhaka.

Ranjhan SK and K Singh (1993). Nutrient requirements, feeding standards and feeding of ruminants and their relevance to Indian condition. In: Feeding of ruminants on fibrous crops residues. (Editors, Kiran Singh and J. B. Schere*). Indian council of Agricultural Research. Krishi Bhavan, New Delhi, India, P. 117-130.*

Kent LA and A Lauchli (1985). Germination and seedling growth of cotton: Salinity calcium interactions. *Plant, Cell Environ.*, 8: 115-159.

Munns R and M Tester (2008). Mechanisms of salinity tolerance. *Ann. Rev. Plant Biol.*, 59: 651-681.

Nadeem M, A Younis, A Riaz, M Hammed, M Nawaz and M Qasim (2012). Growth response of some cultivars of Bermuda grass (Cyanodon Dactylon L.) to salt stress. *Pak. J. Bot*., 44(4): 1347-1350.

Oztekin GB and Y Tuzel (2011). Comparative salinity responses among tomato genotypes and root stocks. *Pak. J. Bot*., 43(6): 2665-2672.

Pessarakli M and DM Kopec (2009*).* Screening various ryegrass cultivars for salt stress tolerance. *Journal of Food, Agriculture & Environment* Vol.7 (3&4): 739-743.

Preston TR and RA Leng (1987). Matching ruminant production system with available resources in the tropics and sub-tropics. *Panabut Books, Armidale, NSW Australia*

Ranjhan SK and K Singh (1993). Nutrient requirements, feeding standards and feeding of ruminants and their relevance to Indian condition. In: Feeding of ruminants on fibrous crops residues.

Shimul MAH, Ito Shin-ichi, S Sadia, MZK Roni and AFMJ Uddin (2014). Response of Tomato (*Lycoperscon esculentum*) to salinity in hydroponic study. *BANGLADESH RESEARCH PUBLICATIONS JOURNAL*. Volume: 10, Issue: 3, Page: 249-254.

Suplick-Ploense MR, YL Qian and JC Read (2002). Relative NaCl tolerance of Kentucky bluegrass, Texas bluegrass, and their hybrids. *Crop Sci.*, 42: 2025-2030.

SRDI (2010). Coastal area and water salinity map of Bangladesh (1981 and 2001). Soil Resources Development Institute (SRDI), Khulna.

Tal MM and C Shannon (1983). Salt tolerance in the wild relatives of the cultivated tomato: Response of Lycopersicon esculenturn Mill., L. cheesrnanii, L. peruvian urn and Solanurn pennellii and F1 hybrid to salinity. Aust. J. Plant Physiol., 10: 109-117.

Wambua JM, MN Makobe, EM Njue and AB Nyende (2010). Hydroponic screening of Sorghum (*Sorghum bicolor* L. Moench) cultivars for salinity tolerance. Jomo Kenyatta University of Agriculture and Technology JAGST Vol. 12(2):202.