Effect of salinity on warm season turf grass species

Abstract

The demand for salinity tolerant turf grasses is increasing due to augmented use of effluent or low-quality water for turf irrigation. Fresh water, along with soil Stalinization in many locations, has raised the requirement for salt-tolerant turf grass screening. Physiological responses to salinity and relative salt tolerance of Five C4 turf grasses, two variety of*Cynodondactylon* (Bermuda grass), *Zoysiamatrella* (Manilla grass), *Zoysia japonica* (Zoysia Grass) and *Paspalumnotatum* (Bahia grass) were investigated during the study at Department of Horticulture Sam Higginbottom University of Agriculture Technology and Science, Prayagraj. Turfgrasses were planted in plastic pots filled with sand: cocopeat: vermiculite (2:1:1) and irrigated with different concentration of salinity levels (0.6, 5.0, 10.0, 15 dS m^{-1}). Salinity tolerance was evaluated based on leaf length leaf Wirth leaf firing, shoots and root growth reduction, proline content, total chlorophyll content RGB content and relative water content was subjected to analysis of variance. Among the four turf grass species Bahia grass found to be most salt tolerant turf grass followed by Z. matrella while Zosia japonica was least tolerant turfgrass against salt stress.

Key words: Cynodondactylon, Paspalumnotatum, Turfgrass, Zoysiamatrella, dS m^{-1}.

Introduction

“Salinity causes major environmental factors limiting plant growth and productivity in many areas of the world. Salinity is one of the most important abiotic stresses widely distributed in both irrigated and non-irrigated areas of the world. Plants that grow on saline soils are confronted with soil solutions exhibiting a wide range of concentrations of dissolved salts. Concentrations fluctuate because of changes in water source, drainage, evapo transpiration, solute availability, and hydrostatic pressures. The leaves of glycophytic plants cannot retain high levels of salt without injury. In addition to the osmotic effect of concentrated solutes, there are ionic effects that arise from the specific composition of the solute flowing through plant tissues. Internal excesses of ions may cause membrane damage, which interferes with solute balances or causes shifts in nutrient concentrations. Some specific symptoms of plant damage which may be recognized especially in the leaves are color change, tip-burn, marginal necrosis, and succulence. There are several potential turf grass species that may be appropriate at various salinity levels of seawater. The demand for salinity-tolerant turf grasses is increasing due to augmented use of effluent or low-quality water (sea water) for turf irrigation. This need has been exacerbated by rapid urbanization (and associated turf grass acreage increase) in arid/semiarid regions having intense competition for limited potable water resources and in coastal areas where salt water intrusion into fresh water irrigation wells is common". [22]"Salinity is a major a biotic environmental stress that is reported to be responsible for reducing plant growth across the globe. Salt tolerant turf grass are becoming essential in many areas of the world because of salt accumulation on soil restriction on ground water use and salt water intrusion into ground water" (Hixson *et al.*, 2004)[1]. "Physiological response to salinity includes growth suppression and lowered osmotic potential" (Marcum 2006).

" Salt tolerant plants have the ability to minimize these detrimental effects by producing a series of morphological, physiological and biochemical process" (Jocaby 1999). "Sodium chloride (Nacl) is the major compound contributing salinity in soils and more salt tolerant turf grass are required to cope the problem". (Harivandi*et al.*,1992)[2]. "Osmotic balance or osmoregualtion is certainly a crucial factor for the survival of a plant under salt – stressed condition. Generally plant hasplant have developed different adaptive mechanism to mitigate salinity under salinity under saline environments" (Rohodes and Orczyk 2002;Borsani*et. al.* 2003;Sairam*at, al.,* 2006)[3].

The goal of this review is to create greater awareness of salt-tolerant turf grasses, their current and potential uses, and their potential use in developing countries. The future for irrigating turf may rely on the use of moderate-to high-salinity water and, in order to ensure that the turf system is sustainable, will rely on the use of salt-tolerant grasses and an improved knowledge of the effects of salinity on turf grasses.

“Among these, salt exclusion is considered to be the most important adaptive feature of nonhalophytic plants, whilst most tolerant halophytes are salt accumulators” (Munns and Tester 2008). “Salt-accumulating halophytes are very crucial for osmotic adjustment. It could be achieved in the following ways: (i) by accumulating inorganic osmolyte (K+) and/or (ii) accumulating organic osmolytes such as proline. Therefore, salt-tolerant halophytic plants have the capability to minimize the detrimental effects by morphological means and physiological or biochemical processes” (Jacoby 1999). “Some of the turf grass species are halophytic in nature. So salt-tolerant turf varieties would allow landscape development in saline environments and would be ideal in such environments, where limited or no fresh water is available for irrigation and saline water is the only option for irrigation practices. Interestingly, the development of turf grass industry especially in the coastal areas of India is an emerging field. To the best of our knowledge, published literatures are very scanty on salt tolerance studies in turf grass species, which have been or being conducted in India. Therefore, this study was framed to determine the relative salinity tolerance and growth response of five important turfgrass species to salinity.The relative salt tolerance among most of the widely used turfgrass species and cultivars has not been adequately studied. Those species possessing some level of salt tolerance could provide more acceptable turf in areas where only low quality irrigation water is available or saline soil conditions exist. Many plants can be grown using land and water unsuitable for conventional crops and can provide food, fuel, fodder, fibber, resin, essential oils, and pharmaceutical products and can be used for landscape reintegration. There are a number of potential turfgrass species that may be appropriate at various salinity levels”. [21]

This study was carried out into response of warm season turf grasses on different levels of salinity and the study of the performance of different warm season turf grasses.

Materials and methods

The present study entitled Effect of Salinity on Warm season turf-grass species was carried out at Department of Horticulture, Naini agriculture Institute, Sam Higginbottomuniversity of Agriculture Technology and Science NainiPrayagraj U.P. during July to December 2022. The objective was finding the most salt tolerant turf grass species and most suitable turf grasses in Prayagraj agro climatic condition. The detail of various material used and the method employed in carrying out the experiment and described in the detailed in this chapter under appropriate heading.

Table 1 Turf grass species used in this study

Sl No.	Variety
1	Manila grass (*Zoysia. Matrella)*
2	Bermuda grass Tift-Dwarf-419
3	Bahia Grass (*Paspalumnotatum)*
4	Bermuda grass Selection-1 (*Cynodondactylon)*
5	Zoysia /Japanese lawn grass (*Zoysia. japonica*)

Visual Appeal of Turf: -The colour of individual green leaves recorder with RHS colour chart and corresponding colour was recorded for visual appeal of turf.

Fresh weight of Shoot: - "At the end of experiment (four weeks after salt initiation), shoots above the soil surface were harvested and washed with tap water and then distilled water to remove all potting mixture particles". [21]

Dry weight of Shoots: - "After harvesting the shoots, roots were removed from the pots, washed with tap water, and rinsed with distilled water. The shoot and root samples were then oven-dried to a constant weight at 70°C for 3 days. The dry weight (g/pot) was recorded for each treatment".[21]

Dry weight of Roots:- "At the end of experiment (four weeks after salt initiation), shoots above the soil surface were harvested and washed with tap water and then distilled water to remove all potting mixture particles then weighted is estimated. The root samples were then oven-dried to a constant weight at 70°C for 3 days. The dry weight (g/pot) was recorded for each treatment". [21]

Leaf Length: - Leaf length was taken before application of treatment and after application of treatment on weekly basis.

Leaf Width: - Leaf width is taken before application of treatment and after application of treatment on weekly basis.

Firing of Leaves: -"Leaf firing was estimated as total percentage of chlorotic leaf area, with 0% corresponding to no leaf firing and 100% for total brown leaves" (Alshammary*et al*., 2004).

Chlorophyll Content: - The leaves were collected from few randomly selected plants for estimating chlorophyll content, Chlorophyll meter SPAD 502 plus were used to know the chlorophyll content in leaves. It measures the absorbance of the leaf in the Red and near-infuriated region. Using this two absorbance the meter calculation a numerical SPAD value is proportional to the amount of chlorophyll present in leaves.

Relative water content: - Relative water content (RWC) was estimated using formula given by Barr (1968) and expressed in percentage. 100 mg of leaf tissue was taken and placed in Petridis for four hours and turgid weight measured. Relative water content was then calculated using the following formula:

RWC (%) = (Fresh weight) - (Dry weight)/ (Turgid weight) - (Dry weight) x 100

Determination of Proline content: - Proline was estimated by following method of (Bates *et al*,.1973). "Fresh leaf tissue (0.5 g) was homogenized in 10ml of 3% sulfosalicylic acid, and the homogenate was filtered through Whatman no. 2 filter paper. Two milliliters of the filtrate were brought to reaction with 2ml acid ninhydrin solution (1.25 g ninhydrin in 30ml glacial acetic acid), 20mL ortho-phosphoric acid (6-M), and 2ml of glacial acetic acid for 1 h at 100◦C. The reaction was terminated in an ice bath. The reaction mixture was extracted with 4mL toluene, mixed vigorously by passing a continuous stream of air for 1-2 min. The chromophore containing toluene was aspirated from the aqueous phase, warmed at room temperature, and the absorbance was recorded spectrophotometrically at 520 nm". [21] The proline concentration was determined from a standard curve and calculated on fresh weight basis as follows:

$$\mu\text{molproline/g fresh weight} = \frac{\mu\text{gproline/ml} \times \text{ml of toluene}}{115.5 \times 100}$$

Result and Discussion: -

1. Determination of visual appeal of Turf Grass (RGB Content before Treatment): -

ThedatapresentedinTable2inrelationtoleafcolo urofdifferentturfgrassesrecordeddifferentcolou raccordingto RHS colourchart before or after treatment. After the Nacl treatment the different turf grasses exhibited colour which ranged from green group N 144 A in Manila grass, N144 B was found in Bermuda grass Var. Tif- Dwarf N144 D was found in Hybrid Bermuda grass Var. Selection- 1 and 145 D was found in Zoysia grass. During the month of December Significantvariationinleafcolouramongdifferen tturfgrassescouldbeattributedtotheirgenetic makeup resulting in different pigments and their proportion leading to different colourinturfgrasses.

2. Fresh Weight of Shoot (g)

It is clear from the data presented in Table3 that the effect of treatment, species and interaction was found in significant with respect to fresh shoot weight. Among the different turf grass species, it was found in maximum fresh shoot weight in Bahia grass (90.64 g/pot) followed by Hybrid Bermuda var. Selection -1 (88.24 g/pot), i.e., 6.24 % and 4.3 % reduction in fresh shoot weight. Among the concentration of Nacl it was observed that

Maximum fresh shoot weight recorded in T_0 i.e., Control (5.16 g/pot) and Minimum was recorded in treatment T_4 at 15 dSm^{-1} (4.14 g/pot). The interaction data show that the fresh shoot weight of all the species significantly decreases with respect to increase salinityeffect.

3. Dry Shoot weight (g)

"It is clear from the data presented in Table 4 that the effect of treatment, species and interaction was found in significant with respect to Dry shoot weight. Among the different turf grass species, it was found in maximum dry shoot weight in Bahia grass (4.15 g/pot) followed by Hybrid Bermuda var. Selection -1 (2.87 g/pot), i.e., 33.33 % and 25% reduction in fresh shoot weight. Among the concentration of Nacl it was observed that maximum fresh shoot weight recorded in T_0 i.e., Control (3.14 g/pot) and Minimum was recorded in treatment T_4 at 15 dSm^{-1} (2.24 g/pot). The interaction data show that the fresh shoot weight of all the species significantly decreases with respect to increase salinity effect. A common response of plant of plants to salinity in shoot dehydration and loss of cell turgor, resulting in reduced growth rate" (Neumann *et al.* 1988)."High shoot growth rate of Bahia grass at the highest salinity may have resulted from maintenance of shoot tissue succulence. Rather than comparing absolute growth rates under salt stress, salinity tolerance is batter expressed as relative shoot growth reduction with increased salinity, which is an indication of relative plant vigor under stress" (Mass and Hoffman 1997).

4. Determination of dry root weight

It is clear from the data presented in Table 5 that the effect of treatment, species and interaction was found to be significant with respect to root dry weight. Root dry weight of all turf grass species was significantly influenced by salinity. Among the different turf grass species, it was found that the maximum root dry weight observed in Hybrid Bermuda var. selection – 1(0.6g/pot) followed by Bermuda grass varTif- dwarf 419 (0.57 g/pot) i.e., 7.98% and 3.78% reduction in root dry weight respectively with respect to control whereas minimum root dry weight was recorded in Manila grass (0.20 g/pot) i.e., 39.37% reduction in root dry weight. Among the concentration of salt (NaClmM) it was observed that maximum root dry weight recorded in T_0, i.e., Control (0.56 g/pot) and minimum was recorded at $T_{4,}$ 15 ds m^{-1}(0.33 g/pot) NaCl salt concentration which represent 36.75% reduction in root dry weight. The interaction data shows that the roots dry weight of all the species significantly decreasing with respect to the increasing salt concentration.

5. Determination of Leaf Length:-

The data presented in Table 6 and fig 1 revealed that the effect of treatment, species and interaction was found to be significant with respect to leaf length. Leaf length of all turf grass species was significantly influenced by salinity.Among the different species and effect of different salinity for leaf length was recorded high in Bahia grass (14 cm) followed by Tif – Dwarf 419 (4.52 cm) and lowest leaf length found in zoysia grass (4.19).

6. Determination of Leaf width

The data presented in Table 7 and fig 2 revealed that the effect of treatment, species and interaction was found to be significant with respect to leaf Wirth. Leaf Wirth of all turfgrass species was significantly influenced by salinity. Among the different species and effect of different salinity for leaf Wirth was recorded high in Bahia grass (0.43 cm) followed by Selection- 1 (0.35 cm) and lowest leaf length found in Tif – Dwarf (0.18).

7. Determination of Lead firing (%)

It is evident from the data in Table 8 that the effect of treatments, species and interaction of salinity and species had significant effect on leaf firing percent. Regardless of salt concentration minimum leaf firing (%) was recorded among the species in Manila grass (17.41) while maximum leaf firing (%) was found in Hybrid Bermuda grass var. Selection -1 (25.73%). However, there was less noticeable salinity injury in Manila grass and Bermuda grass var. Tif- Dwarf 419 at all salinity levels compared to other grasses. Among the treatments of salt concentration (NaClmM) it was observed that maximum leaf firing (%) recorded (40.5) in T_4, 15 dS m^{-1} i.e., salt level and minimum was recorded (0.00%) in treatment T0 (control). At the highest salinity level of 15 ds m^{-1} the least leaf firing was observed in Manila grass (32.13%) compared to (44.26 %) leaf firing in Bahia grass. Thus, leaves firing of different varieties increases in respect to increasing concentration of salt, these findings are in accordance with the earlier report by Uddin*et al.* (2011). Assessment of salinity tolerance using percent leaf firing has been reported in previous studies also (Marcum and Murdoch 1994). In fact, leaf firing has been considered as an important criterion of turf grass assessment under salt stress because leaf firing is easily noticed on turfs and also easily measured.

8. Determination of Chlorophyll content (SPAD Value)

It is clear from the data presented in Table9 that the effect of treatment, species and interaction was found to be significant with respect to total chlorophyll content.

Chlorophyll content of all turfgrass species was significantly influenced by salinity. As salinity increased, chlorophyll content decreased. Among the different turfgrass species it was found that the maximum chlorophyll content (SPAD Value) observed in Zoysia grass (18.40 mg/g) followed by Bahia Grass (18.40 mg/g) and minimum was found in Hybris Bermuda var. selection - 1 (17.06 mg/g). "Among the concentration of salt (NaClmM) it was observed that maximum chlorophyll content recorded in control (21.2 mg/g) and minimum was recorded in T_4 15 dS m^{-1} (14.62 mg/g). Perusal of data in Table 5.2 shows that interaction among species and Nacl concentration resulted and species were ranked at the highest level of salinity in the treatment T_4. Thus, Bahia grass and Zoysiamatrella maintained comparatively higher amounts of total chlorophyll under salt stress with marginal reductions compared to other turf species. The NaCl induced decrease in chlorophyll level is widely reported in both glycophytes and halophytes" (Abdullah et al. 2001, Shabala*et al.*, 2005). "Salinity-induced chlorophyll reduction may be related either to Mg deficiency and/or chlorophyll oxidation since reactive oxygen species (ROS) generation is common in salinity stressed conditions" (Moradi and Ismail 2007).

Similar resultswerereportedby**Babita *et al.*(2019)** in salinity effect of different turfgrassspecies.

9. Determination of Proline content (*µ*mole/gfw)

The data for proline content was analyzed and presented in Table10It is clear from data that the shoot proline content of all grasses increased with increasing salinity. Regardless of salt concentration maximum proline content was recorded among the species in Bahia Grass (7.61µmole/gfw) while minimum was found in manila grass (13.52 µmole/gfw). Among the treatments of salt concentration (NaClmM) it was observed that maximum proline content recorded (7.5 µmole/gfw) in 15 dS m^{-1}salt level and minimum was recorded (2.83 µmole/gfw) in control. The interaction data shows that the proline concentration of all the species significantly increasing in respect to the increasing salt concentration. All the grasses exhibited lower proline content at control condition but it increased as salinity level increased from control to 15 ds m^{-1} salt concentration. The maximum proline content observed in Bahia grass (10.2 µmole/gfw) followed by Zoysia grass (8.4 µmole/gfw) at 15 dS m^{-1} salt concentration while minimum was recorded in Mania grass (25.47 µmole/gfw). "Some compatible solutes that show an increase in concentration under salinity stress may also play significant role in osmotic adjustment, and these include proline, glycine betaine, and sugars" (Storey and Jones 1979). "Glycine betaine and proline protect enzymes (proteins) from damages caused by salinity or dehydration stress" (Paleg et al. 1984, Smirnoff and Cumbes 1989) "interestingly, significant proline accumulation generally occurs only after exceeding a threshold of drought or salt stress" (Cavalieri and Huang 1979). In the current study, salinity triggered proline synthesis in response to salinity to turgor maintenance (Table9).

10. Determination of Relative water content

It is clear from the data presented in Table 11 that the effect of treatment, species and interaction was found to be significant with respect to relative water content (RWC). Relative water content of all turfgrass species was significantly influenced by salinity. As salinity increased, RWC decreased. Among the different turfgrass species it was found that the maximum relative water content (%) observed in case of Bermuda grass var. Tif – Dwarf 413 (33.36%) followed by Zoysiamatrella (30.34%) and minimum RWC found in case of Bahia Grass (27.68%). Among the concentration of salt (NaClmM) it was observed that maximum RWC (%) recorded in T0, i.e., control (35.38%) and minimum was recorded in treatment T_4 at 15 dS m^{-1} (25.76%) Nacl salt concentration. Perusal of data in Table 5.4 shows that interaction among species and NaCl concentration resulted and species were ranked at the highest level of salinity in the treatment T_4 at 15 dS m^{-1} as Bermuda grass var. Tif-Dwarf 419 (30.1%), Zoysiamatrella (25.5%), Manila grass (25.1%) than Hybrid Bermuda var. selection- 1 (25.1%) and Bahia grass (23.1%). "The percentage relative water content (RWC) was determined as an indicator of osmotic status of turfgrass species studied. Salinity stressed plants certainly face osmotic challenges. This is in agreement with several previous reports" (Munns and Tester 2008, Lee et al. 2004) "which concur that osmotic adjustment is the main mechanism for survival and growth of plants under salinity stress. Plants osmotic adjustment subjected to salt stress can occur by the accumulation of high concentration of either inorganic ions or low molecular weight organic solutes. Our studies indicated that salinity tolerance in relation to relative water content was better in Bahia grass followed by Zoysiamatrella. These new salt tolerant species provide an opportunity to use very brackish sources of water" (Uddin and Juraimi 2013).

Table 2 Effect of salinity of warm season turf grass species of RGB color chart

Sl. No	Varieties	Leaf colour of turf grass
1	Manila Grass	N144A
3	Bahia Grass	N144D
4	Selection 1	144D
5	Zoysia Grass	145 D

Table 3 Effect of salinity on worm season turf grass species of fresh shoot weight

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	4.43	4.03	3.93	3.63	3.4	3.884
Tif-Dwarf	4.46	4.26	4.1	3.93	3.4	4.03
Bahia Grass	6.73	6.46	6.2	6.06	5.9	6.27
Selection-1	4.76	4.63	4.26	4.13	3.83	4.322
Zoysia Grass	5.42	4.9	4.63	4.5	4.1	4.71
MEAN	5.16	4.86	4.62	4.45	4.13	
CD% (0.05)						
Species (S)	0.15					
Treatment (T)	0.15					
Interaction (A*B)	0.32					

Table 4 Effect of salinity on warm season turf grass species of Dry shoot weight

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	2.4	2.2	2	1.8	1.5	1.98
Tif-Dwarf	2.4	2.1	2	1.7	1.4	1.92
Bahia Grass	4.66	4.2	4.2	4	3.7	4.152
Selection-1	3.26	3.1	2.9	2.7	2.4	2.872
Zoysia Grass	3	2.8	2.6	2.3	2.2	2.58
MEAN	3.144	2.88	2.74	2.5	2.24	
CD% (0.05)						
Species (S)	0.126					
Treatment (T)	0.126					
Interaction (A*B)	0.289					

Table 5 Effect of salinity on warm season turf grass species of Dry root weight

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	0.14	0.16	0.17	0.16	0.38	0.202
Tif-Dwarf	0.87	0.27	0.9	0.44	0.41	0.578
Bahia Grass	0.43	0.34	0.94	0.65	0.36	0.544
Selection-1	0.84	0.44	0.55	0.97	0.24	0.608
Zoysia Grass	0.54	0.58	0.3	0.76	0.28	0.492
MEAN	0.564	0.358	0.572	0.596	0.334	
CD% (0.05)						
Species (S)	0.027					
Treatment (T)	0.027					
Interaction (A*B)	0.061					

Table 6 Effect of salinity on warm season turf grass species of Leaf Length

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	5	4.3	4.4	5	4.2	4.58
Tif-Dwarf	5	4.3	5	3.9	4.4	4.52
Bahia Grass	15.3	13.4	14	13.9	13.4	14
Selection-1	4	5.1	5	4.2	4.2	4.5
Zoysia Grass	4.2	4	4.3	4.2	4	4.14
MEAN	6.7	6.22	6.54	6.24	6.04	
CV	3.09					
CD% (0.05)						
Species (S)	0.16					
Treatment (T)	0.25					
Interaction (A*B)	0.559					

Table 7 Effect of salinity on warm season turf grass species of Leaf width

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	0.18	0.23	0.22	0.17	0.18	0.20
Tif-Dwarf	0.16	0.18	0.18	0.19	0.18	0.18
Bahia Grass	0.43	0.44	0.41	0.44	0.43	0.43
Selection-1	0.43	0.35	0.30	0.35	0.33	0.35
Zoysia Grass	0.22	0.22	0.24	0.24	0.25	0.23
MEAN	0.28	0.28	0.27	0.28	0.27	
CD% (0.05)						
Species (S)	0.011					
Treatment (T)	0.011					
Interaction (A*B)	0.024					

Table 8 Effect of salinity on warm season turf grass of Leaf firing

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	0	13.96	18.16	22.8	32.13	17.41
Tif-Dwarf	0	13.63	18.3	28.3	39.4	19.92
Bahia Grass	0	17.1	22.1	32.06	44.26	23.1
Selection-1	0	22.6	27.33	35	43.73	25.73
Zoysia Grass	0	20.33	26.53	35.36	43	25.04
MEAN	0	17.52	22.48	30.7	40.5	
CV						
CD% (0.05)						
Species (S)	1.68					
Treatment (T)	1.68					
Interaction (A*B)	3.77					

Table 9 Effect of salinity on warm season turf grass of Chlorophyll content (SPAD Value)

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	20.3	16.7	14.2	11.6	11.1	14.78
Tif-Dwarf	21.7	19.9	18.2	16.7	15.3	18.36
Bahia Grass	22.6	20.3	18	16.1	15	18.4
Selection-1	20.8	18.8	18.2	16.3	15.2	17.86
Zoysia Grass	20.6	19.3	18.6	17.4	16.5	18.48
MEAN	21.2	19	17.44	15.62	14.62	
CV	5.94					
CD% (0.05)						
Species (S)	0.766					
Treatment (T)	0.766					
Interaction (A*B)	1.712					

Table 10 Effect of salinity on warm season turf grass of Proline content

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	2.13	4.46	4.8	5.26	5.6	4.45
Tif-Dwarf	2.16	4.86	5.16	5.63	6.53	4.868
Bahia Grass	4.63	6.43	7.9	8.9	10.2	7.612
Selection-1	2.76	3.66	4.7	5.9	6.67	4.738
Zoysia Grass	2.5	4.9	6.5	8	8.5	6.08
MEAN	2.836	4.862	5.812	6.738	7.5	
CD% (0.05)						
Species (S)	0.189					
Treatment (T)	0.189					
Interaction (A*B)	0.423					

Table 11 Effect of salinity on warm season turf grass of Relative water content

Species	T0 (Control)	T1 (0.6 dS m^{-1})	T2 (5.0 dS m^{-1})	T3 (10 dS m^{-1})	T4 (15 dS m^{-1})	MEAN
Manila Grass	34.9	31.4	27.5	26.1	25.1	29
Tif-Dwarf	36.9	35.2	32.8	31.8	30.1	33.36
Bahia Grass	34.3	29.9	26.7	24.4	23.1	27.68
Selection-1	32.8	31.3	30	28.4	25	29.5
Zoysia Grass	40.1	30.3	28.7	27.1	25.5	30.34
MEAN	35.8	31.62	29.14	27.56	25.76	
CD% (0.05)						
Species (S)	3.09					
Treatment (T)	3.09					
Interaction (A*B)	8.92					

Conclusion

On the present experiment, it is concluded that the development of turf grass industry in the salt affected is challenging due to scarcity of fresh water for irrigation. Appropriate realistic physiological criteria are essential to define the salinity tolerance and growth response of turf grass species. Among the salinity effect studies Bahia grasses is shown best result with respect of Day taken establishment, Leaf length, Leaf width, Fresh shoot weight, Dry shoot weight, &Proline content. Highest clipping yield, mowing frequency and chlorophyll content is shown in Zoysia grass. Highest leaf firing and dry root weight is shown in Selection – 1. Relative water content is shown in Tif – Dwarf Species. Earlier establishment of turf grasses is shown in Manila grass. The conclusion is based on response of five turf grass species to salinity tolerance.

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