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Evaluation of Native Ornamental Lawn Grass Species under Water Deficit Conditions

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ABSTRACT

Lawn grasses are the most important ground cover plants in the world. The knowledge of relative drought resistance among the lawn grass species is important for selecting lawn grasses that persist during drought stress. A pot experiment was conducted to evaluate the growth performance of three ornamental grass species *viz. Cynodon dactylon, Desmodium triflorum* and *Cyrtococcum trigonum* under water deficit conditions. Three water deficit levels (75%, 65% and 55% field capacity) and control 100% field capacity were maintained throughout the experiment. Growth parameters including fresh and dry weights of roots and shoots, root and shoot length, leaf length and width, as well as lawn quality were measured. Over all lawn quality of all three species decreased with the series of deficit irrigation. *Cynodon dactylon* was the least affected species to water deficit conditions compared to *Desmodium triflorum* and *Cyrtococcum trigonum*. Therefore, it can be recommended for lawn establishment under drought conditions in any part of the country as it is a naturally occurring plant in all the three major climatic zones of Sri Lanka.

KEYWORDS: Deficit irrigation, Growth parameters, Lawn quality, Ornamental lawn grass

INTRODUCTION

Drought is often defined in climatic terms as a continuous interval of time during which the actual moisture supply at a given place is consistently less than normal. This results in a water shortage condition that seriously interferes with plant activity (Riaz *et al.*, 2010). Many effects of drought can be listed as economic, environmental or social (Anon., 1996), including a significant reduction in crop yields and loss of livestock due to lack of water availability.

Drought or water deficit condition is one of the most serious environmental hazards while in Sri Lanka, 70% of the area is characteristically dry lands belongs to dry zone (Anon., 2010) with high temperature and comparatively low rain fall. Rainfall received across Sri Lanka varies dramatically from year to year. The annual rainfall of the country is conventionally considered as ranging between 1,000 mm in the driest parts to more than 5,000 mm in the wettest parts. There is a marked spatial pattern associated with the mean annual rainfall over Sri Lanka (Manawadu and Fernando, 2008).

Research related to water stress is becoming increasingly important because changing climatic scenario is increasing aridity in many areas of the globe. It is now known that extent of drought tolerance, varies from species to species in almost all plant species (Lin *et al.*, 2006). Drought tolerance, particularly in grasses is associated closely with their morphological and physiological traits (Bahrani *et al.*, 2010). Landscapes containing low water use plants are promising alternatives to conventional lawn grass-based landscapes and have the potential to significantly reduce overall landscape water use (Heflebower *et al.*, 2005). However, lawn grass is the most important groundcover in the world and the knowledge of relative drought resistance is important for selecting lawn grass that can sustain during drought period (Fu *et al.*, 2005). Deficit irrigation has been successfully used on some lawn grasses for water conservation without significant loss of lawn quality (Brown *et al.*, 2004).

Lawn grass is mainly used for ornamental lawns, athletic fields, and golf courses. Proper selection and care of lawn grass depends upon knowledge of the environmental adaption, cultural requirements and quality features of grass species. Drought stress is a major limiting factor for both cool- season and warm season grasses. For making the lawn grasses water stress tolerant, understanding about plant responses to water- limited environment is of great importance (Levitt, 1972).

In arid and semiarid areas, irrigation for lawn grass is a major problem. Therefore, there is a need to explore natural drought resistant lawn species for such areas (Carrow and Duncan, 2003). Therefore, the objective of this study was to investigate the effects of drought on three different native lawn grass species *viz., Cynodon dactylon, Desmodium triflorum, Cyrtococcum trigonum* and check their growth performance and lawn quality under water deficit conditions.

MATERIALS AND METHODS

The study was carried out under a rain shelter at the faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, situated in the Low Country Intermediate zone (IL_{1a}) at the elevation of 30m above mean sea level during the period from January to April 2013.

Three grass species *viz*., *Cynodon dactylon* (Burmuda grass), *Desmodium triflorum* and *Cyrtococcum trigonum* were collected from Makandura premises of Wayamba University of Sri Lanka. Grass runners were planted in black polyethylene bags (12 cm diameter × 20 cm depth) containing 1.55 kg of sandy loam soil (top soil: sand 9: 2). Plants were allowed to establish for 50 days and a foliar nutrient was applied to enhance the growth. Pots were arranged in Completely Randomized Design (CRD) and each treatment consisted with 25 samples.

Grasses were clipped at 12 cm diameter of coverage before the start of water deficit treatments and water stress was applied on the basis of soil field capacity. A quick method described in NifTAL manual (Somasegaran and Heben, 1985) was used to determine percent soil moisture that approximates field capacity (FC). Three water deficit treatments (75%, 65% and 55% FC) along with 100% field capacity (control) were applied at four days intervals (Table 1).

Table 1. Details of treatment combinations used in the experiment

Treatment	Grass species	FC%
T_1	*Cynodon dactylon*	100
T_2	*Cynodon dactylon*	75
T_3	*Cynodon dactylon*	65
T_4	*Cynodon dactylon*	55
T_5	*Desmodium triflorum*	100
T_6	*Desmodium triflorum*	75
T_7	*Desmodium triflorum*	65
T_8	*Desmodium triflorum*	55
T_9	*Cyrtococcum trigonum*	100
T_{10}	*Cyrtococcum trigonum*	75
T_{11}	*Cyrtococcum trigonum*	65
T_{12}	*Cyrtococcum trigonum*	55

Data Recording

Growth parameters including fresh and dry weights (g) of roots and shoots, root and shoot length (cm), leaf length and leaf width (cm), as well as lawn quality were recorded. Lawn quality was determined based on colour, leaf coverage, appearance and growth by conducting a survey with 20 people.

The Scale of Lawn Quality Evaluation

5-Very good, 4-Good, 3-Medium, 2-Poor and 1-Very poor

Statistical Analysis

Lawn quality was analyzed with non-parametric analysis methods (Friedman test) and other quantitative data were analyzed with SAS statistical package.

RESULTS AND DISSCUSSION

Shoot Growth Parameters

All three grass species recorded maximum shoot fresh weights at 100% FC level (Table 2). Similar observations were made for shoot dry weight of *C. dactylon* and *D. triflorum* except *C. trigonum* (Table 3). Water deficit conditions had a significant inhibitory effect on shoot fresh and dry weights (Riaz, 2010).

Table 2. Shoot fresh weight (g) of grass species at different FC% levels

FC	Shoot fresh weight (g)		
%	*C. dactylon*	*D. triflorum*	*C. trigonum*
100	10.480^{a}	9.228^{a}	8.092^{a}
75	8.100^{b}	6.492^{b}	5.748^{b}
65	8.376^{b}	5.976^{bc}	4.908^{b}
55	8.224^{b}	4.876^{c}	3.908^{c}

Means in a column with the same letters are not significantly different at the 0.05 probability level

Table 3. Shoot dry weight (g) of grass species at different FC% levels

FC	Shoot dry weight (g)		
%	*C. dactylon*	*D. triflorum*	*C. trigonum*
100	5.208^{a}	3.204^{a}	2.720^{a}
75	3.720^{b}	2.388^{ab}	2.056^{ab}
65	3.740^{b}	2.152^{ab}	1.804^{ab}
55	3.228^{b}	1.832^{b}	1.544^{b}

Means in a column with the same letters are not significantly different at the 0.05 probability level

In *C. dactylon*, shoot fresh and dry weights were not significantly different among water deficit treatments. *Cynodon dactylon* showed more shoot fresh and dry weights, even under severe water stress, with less reduction in relative growth (Table 4). Both the actual and relative growth values are important indications in such studies. The actual values would give indication of the actual field situation of lawn quality and the relative values indicate the level of growth resistance against drought (Riaz, 2010). An overall result for shoot fresh and dry weights shows that *C. dactylon* has better ability to cope with drought stress when compared to other two species.

Table 4. Relative growth (%) in various growth parameters at 55% FC compared with 100% FC

Growth parameters	Grass species		
	A	B	C
Shoot fresh weight	78	52	48
Shoot dry weight	62	57	57
Shoot length	99	86	63
Root fresh weight	63	56	21
Root dry weight	50	65	45
Root length	100	100	83

Grass species: Cynodon dactylon - A , Desmodium triflorum – B, Cyrtococcum trigonum - C

Effect of water stress on shoot length was found not significant in all species except in *C. trigonum* between control and water deficit levels (Table 5). The relative growth (Table 4) in shoot length higher in *C. dactylon* than other two species.

Table 5. Shoot length (cm) of grass species at different FC% levels

FC %	Shoot length (cm)		
	C. dactylon	*D. triflorum*	*C. trigonum*
100	97.64^{a}	35.40^{a}	64.00^{a}
75	111.44^{a}	32.96^{a}	52.20^{ab}
65	99.48^{a}	34.16^{a}	42.32^{b}
55	97.44^{a}	34.16^{a}	40.40^{b}

Means in a column with the same letters are not significantly different at the 0.05 probability level

Root Growth Parameters

Beside shoots and leaves, root growth is an important parameter for plant tolerance to drought stress as roots are the main engine for meeting transpirational demand, and play an important role in making water available to plants (Huang and Gao, 1999). Results indicate that, difference in root fresh weight in *C. dactylon* was significantly different only under 55% FC level (Table 6). However, in *D. triflorum* and *C. trigonum* all the water deficit treatments were significantly different from control and similar results were observed for root dry weights (Table 7) in *D. triflorum* and *C. trigonum.* Root fresh and dry weights are related with root volume. When root volume increases, the capability to uptake water also increases. Therefore, *C. dactylon* would have relatively higher drought tolerance.

Table 6. Root fresh weight (g) of grass species at different FC% levels

FC %	Root fresh weight (g)		
	C. dactylon	*D. triflorum*	*C. trigonum*
100	3.168^{a}	2.024^{a}	1.724^{a}
75	3.132^{a}	1.076^{b}	0.928^{b}
65	2.624^{a}	1.072^{b}	0.572^{c}
55	1.996^{b}	0.972^{b}	0.428^{c}

Means in a column with the same letters are not significantly different at the 0.05 probability level

Table 7. Root dry weight (g) of grass species at different FC% levels

FC %	Root dry weight (g)		
	C. dactylon	*D. triflorum*	*C. trigonum*
100	1.424^{a}	0.744^{a}	0.652^{a}
75	1.288^{a}	0.420^{b}	0.408^{b}
65	0.932^{ab}	0.468^{b}	0.380^{b}
55	0.720^{b}	0.468^{b}	0.296^{b}

Means in a column with the same letters are not significantly different at the 0.05 probability level

Root lengths were not significantly different under any water level in all the three species except at 55% FC in *C. trigonum* (Table 8). The relative growth (Table 4) in root length was higher in both *C. dactylon* and *D. triflorum.*

Table 8. Root length (cm) of grass species at different FC% levels

FC %	Root length (cm)		
	C. dactylon	*D. triflorum*	*C. trigonum*
100	36.12^{a}	21.76^{a}	25.88^{a}
75	43.96^{a}	21.52^{a}	28.48^{a}
65	43.60^{a}	22.44^{a}	27.08^{a}
55	36.36^{a}	21.40^{a}	21.76^{b}

Means in a column with the same letters are not significantly different at the 0.05 probability level

Leaf Length and Width

Effect of water stress on leaf length and width was found not significant in any species.

Lawn Quality Evaluation

The highest visual quality ranks were recorded in *D. triflorum* on the basis of colour while the lowest ranks were recorded in *C. trigonum* (Table 9). Ranks for the colour of *D. triflorum* and *C. dactylon* were decreased according to the reduction of FC%. There was no effect of water stress on the colour in *D. triflorum.*

Table 9. Median level of lawn quality acceptance ranks of all the treatments

Quality evaluation attributes	Grand median	Species											
		Cynodon dactylon				*Desmodium triflorum*				*Cyrtococcum trigonum*			
		100 %	75 %	65 %	55 %	100 %	75 %	65 %	55 %	100 %	75 %	65 %	55 %
Colour	3.10	3.52	2.60	2.60	2.56	4.35	3.81	3.65	3.52	2.52	2.81	2.60	2.69
Leaf coverage	3.27	4.19	3.39	3.06	2.23	4.73	3.43	2.97	2.97	4.15	3.27	2.65	2.19
Appearance	3.16	3.62	3.32	3.24	2.19	4.41	3.49	3.19	3.07	3.45	3.12	2.49	2.28
Growth	3.68	4.72	3.80	3.76	2.72	4.76	3.84	3.55	3.12	4.47	3.76	2.93	2.68

Field capacity levels: 100%, 75%, 65%, 55%

Leaf coverage (Table 9) was declined with the reduction of water level in all three species. The ranks for both 100% and 75% FC levels of all three species were recorded as above the acceptable level. Therefore 75% FC also can be applied to obtain good leaf coverage with compare to other two water deficit levels.

There was lawn quality reduction according to the water stress based on appearance. In addition to 100% FC level, 75% and 65% FC levels in *D. triflorum* and *C. dactylon* were also received good ranks for lawn appearance but 100% FC level was the only acceptable level in *C. trigonum* which was severely affected by water stress. Visual growth also decreased with the depletion of irrigation in all three species. Considering all above attributes, overall lawn quality in three species was affected with the progression of drought stress. Based on quality evaluation attributes, *C. trigonum* was the severely affected species compared to other species.

CONCLUSIONS

According to the present study all the three species studied were negatively affected with water deficit conditions. However, *C. dactylon* was the least affected species compared to other two species. Therefore, it can be recommended as a drought resistant lawn grass to introduce into drier parts of the country.The visual quality of each species was reduced due to drought stress. However, a further detailed study is needed to examine biochemical processes and genetic parameters which are responsible for different responses of lawn grasses to drought.

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