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Preliminary studyonphysiologicalcharacteristicsoftallfescue(*Festucaarundinacea*Scherb.)accessionsunder drought stress condition

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ABSTRACT: Turf breeders are searching worldwide to develop plant species and turfgrass cultivars that can grow and perform satisfactory growth in a wide range of climates, soils, and environmental conditions. This preliminary study was conducted in a research greenhouse, to compare growth responses of 45 Iranian tall fescue accessions and one foreign cultivar in terms of physiological changes under drought stress condition to find tolerant accessions. After two months growing, plants were irrigated to 25% FC condition for three times, then fresh leaves were collected for measuring SOD, CAT and APX activities, and proline and total chlorophyll content. Differences among treatment means were assessed by the least significance difference (LSD) at P = 0.05. The results showed that there are big differences between accessionsand foreign cultivar, Khoramabad, and Salmas accessions were tolerant and Sari, Neka, Lahijan, and Chalos accessions were sensitive to drought stress.

Keywords: Accession;Drought; Physiological;Proline; Tall fescue.

INTRODUCTION

Drought stress is an important environmental factor influencing turfgrass growth and distribution in many regions. This stress will become more significant for plant growth as water availability is becoming limited for irrigation and is predicted to rise due to global warming. Drought stress can be detrimental to both warm-season and cool-season Turfgrasses whereasheat stress is a limiting factor primarily for cool-season turfgrasses' growth. Cool-season turfgrass species grow most actively at temperatures ranging from 18^{o}C to 24^{o}C for shoot growth and 10^{o}C to 18^{o}C for root growth, and warm-season turfgrass species are best adapted to warmer climates, commonly having an optimum temperature range of 27^{o}C to 35^{o}C (Beard, 1973). The ability of turfgrasses to tolerate drought stress varies between warm-season and cool-season turfgrasses and also between species within each group. Among cool-season turfgrasses, tall fescue (*Festucaarundinacea*Schreb.) has better ability to avoid drought than other cool-season turfgrasses such as perennial ryegrass (*Loliumperenne*L.) or Kentucky bluegrass (*Poapratensis*L.), which has been mainly attributed to its extensive and prolific rooting characteristics (Sheffer et al., 1987; Carrow, 1996; Qian et al., 1997; Ervin and Koski, 1998; Huang and Gao, 2000). Zoysiagrass species (*Zoysia*spp.) are considered as relatively drought tolerant species within warm-season turfgrasses (Beard, 2004), but may have shallower rooting and thus poor drought avoidance (Qian et al., 1997). Carrow (1996) and Qian et al. (1997) compared drought resistance among several turfgrass species, including tall fescue and zoysigrass, and reported that species variation in drought resistance was largely associated with differences in the deep rooting characteristic.

Many physiological processes are interrupted during drought stress, including photosynthesis, respiration, hormone synthesis, and water and nutrient uptake (Huang, 2004). Photosynthesis is among the most sensitive physiological processes to both high temperature and drought stress, particularly photochemical reactions. Although stress tolerance involves many different factors, cell membrane stability is a basic requirement for the maintenance of physiological functions in plants. Stress-induced loss of cell membrane integrity is associated with an efflux of solutes, and therefore, a relative quantification of the electrolyte leakage from cells or tissues during water or heat stress can be used as a measure of cellular injury (Blum and Ebercon, 1981). Understanding physiological changes to drought and heat stress may further broad our understanding of physiological traits associated with drought and heat tolerance. In addition, knowledge of relative tolerance of different turfgrass species to both heat and drought stresses is important for selecting turfgrasses suitable for hot and dry environments.

The objective of this preliminary study was to investigate the effects of drought stress on physiological characteristics of tall fescue (*Festucaarundinacea*Scherb.) accessions.

MATERIALS AND METHODS

Forty five Iranian accessions and one foreign cultivar (as control) of *F.arundinacea*were collected from different geographical regions (Fig. 1) and moved to greenhouse of Department of Horticultural Science in Shiraz University. They were maintained under ambient temperature at 25±2℃, 70-80% relative humidity. Photosynthetic photon flux (PPF) density was set at 60±5 μmol m^{-2} s^{-1} provided by fluorescence lamps with 16 h d^{-1} photoperiod. The experiment was arranged as a completely randomized design (CRD) with three replications. After two months growing, plantswere irrigated to 25% FC condition for three times, then fresh leaves were collected for measuring superoxide dismutase, catalase, and peroxidase activities, and proline and total chlorophyll content. Physiological characters were assessed in order to classify cultivars as either tolerant or sensitive. Differences among treatment means were assessed by the least significance difference (LSD) at P = 0.05.

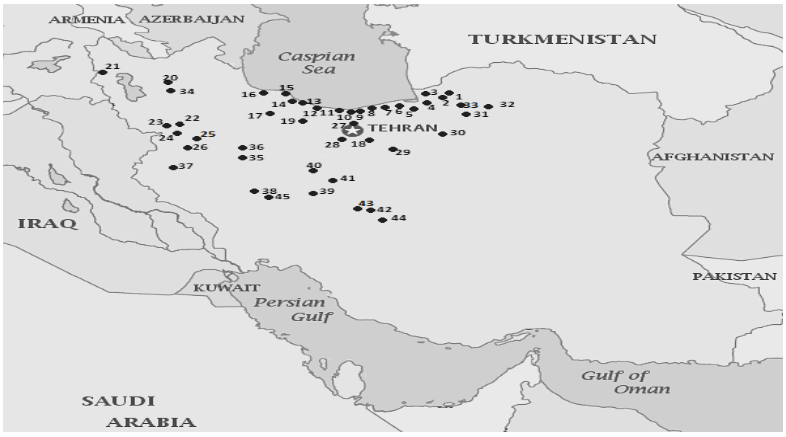

Figure 1.The sampling locations for tall fescue accessions in different regions of Iran.

1=Azadshahr, 2=Ali abad, 3= Gorgan, 4=Bandar gaz, 5=Behshahr 6=Neka, 7=Sari, 8= Qaemshahr 9=Babol, 10= Mahmodabad, 11=Chalos, 12= Tonekabon, 13= Chaboksar, 14=Lahijan, 15=Rasht, 16= Manjil, 17=Kohein, 18=Pakdasht, 19=Gazvin, 20=Bostanabad, 21=Salmas, 22=DivandarehI 23=DivandarehII 24= Saghez 25=Sanandaj, 26=Kamyaran, 27=Karaj, 28=Tehran, 29=Garmsar, 30=Semnan, 31=Damghan, 32=Shahrod, 33=Khoshyeylagh, 34=Hashrod, 35=Hamedan, 36= Alisadr, 37=Islamabad gharb, 38=Khoramabad, 39=Aligodarz, 40=Arak, 41=Golpaygan, , 42=Darehsari 43=Tiran, 44=Borojen, 45=Boloran.

RESULTS

Total protein

The result of total protein showed that there were differences between total protein of different accessions, and the maximum total protein belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession collected from Salmas. The minimum total protein of accessionswas belonged to Sari accession (Table 1).

Proline

The results of prolinecontent showed that there were differences between prolinecontent of different accessions and the maximum prolinecontent was belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession from Khoramabad. The minimum prolineof accessions was belonged to Sari accession (Table 1).

Table 1.Amount of protein, proline, APX, SOD, CAT and Chlorophyll of different Iranian and foreign tall fescues.

Location of accession	Protein content (mg/g F.W.)	Proline content (µm/g F.W.)	APX (U/g F.W.)	SOD (U/g F.W.)	CAT (U/g F.W.)	Chlorophyll content (mg/g F.W.)
Brojen	33.2	27.91	66.5	452	44.1	2.10
Tiran	31.7	30.15	62.6	460	42.8	2.21
Hashtrod	30.9	28.90	70.9	451	43.7	2.14
Saghez	31.4	29.41	72.5	462	42.9	2.17
Hamedan	32.1	28.40	71.5	450	43.6	2.22
Aligodarz	30.8	30.94	66.4	447	42.1	2.13
Divandareh I	30.9	27.90	64.0	459	42.5	2.19
Alisadr	31.3	28.77	69.1	445	43.5	2.21
Boloran	30.6	29.61	69.0	468	44.1	2.14
Bostanabad	29.8	28.92	71.5	455	44.2	2.17
Golpaygan	29.9	28.54	67.5	453	43.6	2.12
Eslamababd	30.8	29.97	67.3	451	42.8	2.19
Arak	31.4	29.72	66.5	462	42.7	2.32
Kamyaran	28.8	30.48	69.6	440	43.5	2.22
Khoramabad	32.4	31.83	69.8	458	42.6	2.35
Salmas	33.8	27.95	68.9	454	44.5	2.17
Darehsari	29.6	29.12	70.5	451	42.4	2.20
Sanandaj	30.3	27.44	72.1	449	42.8	2.16
Divandareh II	31.1	29.99	69.2	456	41.5	2.15
Pakdasht	32.7	30.41	69.1	455	43.4	2.30
Garmsar	31.9	28.46	70.0	460	44.5	2.31
Shahrod	31.4	30.17	70.2	350	43.3	2.27
Tonekabon	23.8	16.41	52.3	347	37.2	0.78
Manjil	24.1	16.52	51.7	344	36.4	0.96
Azadshahr	23.9	17.91	45.5	344	36.1	1.01
Rasht	24.3	17.66	46.3	352	36.9	0.78
Mahmodabad	23.9	17.31	44.8	349	37.2	0.76
Bandar gaz	24.4	18.60	49.3	350	37.5	0.56
Tehran	31.6	29.55	70.5	450	42.6	2.21
Chalos	23.7	17.10	48.7	356	37.5	0.73
Khoshyeylagh	24.7	15.90	45.6	349	35.2	0.89
Aliabad	23.6	15.20	47.2	347	35.3	1.02
Karaj	33.6	30.52	70.7	456	42.9	2.11
Babol	23.6	16.11	43.6	341	37.1	0.92
Chaboksar	22.8	16.70	46.0	337	35.1	0.85
Sari	22.1	15.60	46.5	348	36.5	0.70
Neka	27.3	16.10	48.7	352	37.1	0.62
Qaemshahr	23.6	18.20	49.2	347	36.2	0.59
Qazvin	30.7	28.63	71.7	449	42.7	2.10
Lahijan	22.3	17.31	40.7	346	37.1	0.91
Kohein	31.5	29.43	72.6	470	43.5	2.21
Semnan	33.4	27.60	73.4	356	42.5	2.29
Gorgan	22.6	16.20	44.6	350	36.4	1.20
Damghan	23.7	17.40	49.5	347	39.2	1.10
Behshahr	22.9	15.80	48.7	340	37.8	0.91
Foreign	34.7	34.25	78.3	520	45.4	3.90
LSD (5%)	3.5	2.74	4.2	45.2	1.2	0.029

Peroxidase

The results of peroxidase activity showed that there were differences between peroxidase of different accessions and the maximum peroxidase was belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession collected from Saghez. The minimum peroxidase of accessions was belonged to Lahijan accession (Table 1).

Superoxide dismutase

The results of superoxide dismutase activity showed that there were differences between superoxide dismutase of different accession and the maximum superoxide dismutase was belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession collected from Boloran. The minimum superoxide dismutase of accessions was belonged to Chaboksar accession (Table 1).

Catalase

The results of catalase activity showed that there were differences between catalase of different accessions and the maximum catalase was belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession collected from Garmsar. The minimum catalase of accessions was belonged to Khoshyeylagh accession (Table 1).

Total chlorophyll content

The results of Total chlorophyll content showed that there were differences between total chlorophyll content of different accessions and the maximum total chlorophyll content was belonged to foreign cultivar (control) and then after it was belonged to tall fescue accession collected from Khoramabad. The minimum total chlorophyll content of accessions was belonged to Sari accession.

DISCUSSION

Proline enrichment in the stressed plants is a general response to various abiotic stresses, hence it has been developed as an effective index for stress tolerance identification (Abdel-Nasser and Abdel-Aal, 2002; Akramet al., 2007). Moreover, reactive oxygen species (ROS) production has been reached when plants subjected to water deficit stress. Enrichment of ROS directly exhibitsthe oxidative damage especially constituent change ofunsaturated fatty acids, leading to alter the membranestructure and their properties (Quanet al., 2004).

Antioxidant enzymes' activity increases in plant cells as a response to environmental stresses. Environmental stresses can result in the production of ROS, including O^-, H_2O_2 and OH^-, that adversely affect crops yield and quality (Baby and Jini, 2011; Rahimzadeh et al., 2007). ROSsare highly reactive and can alert normal cellular metabolism through oxidative damage to membranes, proteins and nucleic acids; they also cause lipid peroxidation, protein denaturation and DNA mutation (Baby and Jini, 2011). To prevent damage to cellular components by ROS, plants have developed a complex antioxidant system. The primary components of this system includes carotenoids, ascorbate, glutathione and tocopherols, in addition to enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPX), peroxidases and the enzymes involved in ascorbate-glutathion cycle such as ascorbate peroxidase (APX) and glutathione reductase (GR) (Baby and Jini, 2011). These enzymes have key role in the defense against oxidative stress (Rahimzadeh et al., 2007). Studies on barley, wheat, soybean and chickpea determined that the Catalase activity is effective in reducing the damages of stresses(Sairam and Saxena, 2010). Researches on sunflower, sorghum and soybean showed that drought stress increased the activity of SOD, GPX and CAT(Amman, 2004). Another study showed that applying 21 g of selenium boosted the CAT activity (Shafei, 2005). Sairam and Saxena(2010) studies on three wheat cultivars indicated that drought stress increased lipid peroxidation and enzymes APX, GR and GPX, but reduced the membrane resistance, and chlorophyll and carotenoids content.

The results of chlorophyll content showed that the sensitive accessions had less chlorophyll content. Under the water deficit stress, chloroplast ultra-structures are the first targets to be damaged at the cellular level since it is the major site of ROS production (Munné-Bosch and Peñuelas, 2003). An enriched ROS in stressed tissues impairs cellular membrane and organelles which affects the integrity of cells. Results of this preliminary experiment can be used in further studies on genetic diversity of tall fescue accessions based on phyllogenetical and physiological characteristics.

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