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Investigation on physiological characteristics of in tall fescue (*Festucaarundinacea* Scherb.) accessions tolerance to drought stress

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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 study was conducted in a greenhouse, to compare growth responses of 45 Iranian tall fescue accession and foreign cultivar in terms of physiological changes under drought stresses to find tolerate accession. After two months growing, plant were irrigated to 25% FC condition for three time then fresh leaves were collected again for measuring SOD, CAT and APX activities, proline and total chlorophyll content. Differences among treatment means were assessed by the least significance difference (LSD) at P = 0.05 probability level. The results showed that there are very different between accession as drought stress tolerant and foreign cultivar, Khoramabad, Salmas accessions were tolerate and Sari, Neka, Lahijan and Chalos accessions were sensitive.

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

INTRODUCTION

Drought stress is important environmental factors influencing turfgrass growth and distribution in many regions. This stress will become more significant for plant growth as water availability is becoming increasing limited for irrigation is predicted to rise due to global warming. Drought stress can be detrimental to both warm-season and cool-season turfgrasseswhereasheat stress is a limiting factor primarily for cool-season turfgrass 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.) is better able 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 a 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 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 study was to investigate differential effects of drought on tall fescue accession (*Festucaarundinacea*Scherb.). Physiological and morphological characteristics were examined.

MATERIAL 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, plant were irrigated to 25% FC condition for three time then fresh leaves were collected again for measuring superoxide dismutase, catalase, peroxidase activities, 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 probability level.

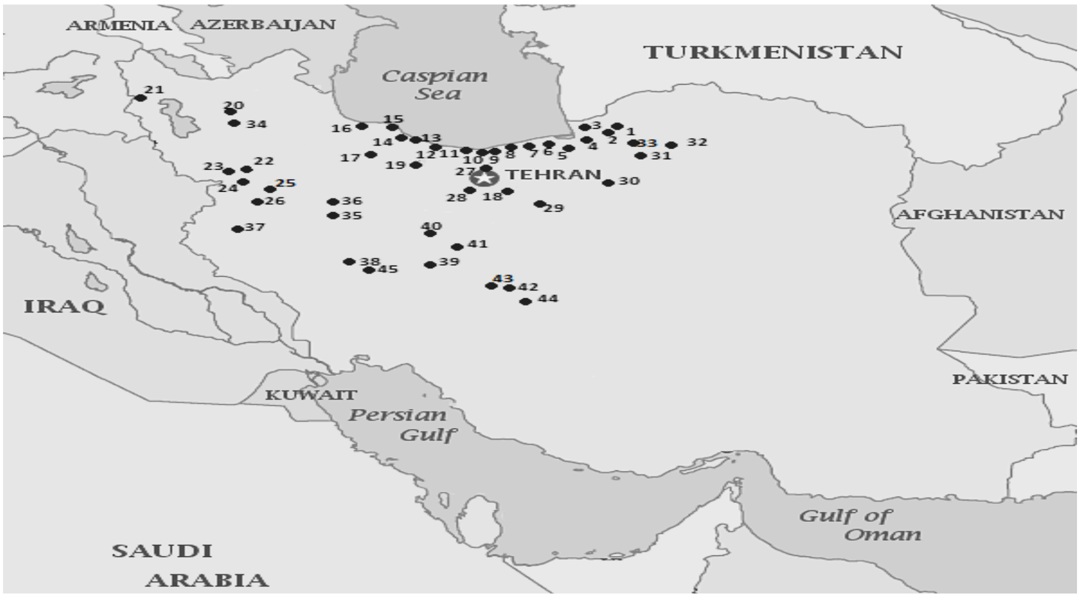

Figure 1.The sampling locations for tall fescue isolates in different regions of Iran.

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 shown that there were different between total protein from different accession and the maximum total protein belonged toforeign accession (control) and after it's belonged to tall fescue accession from Salmas. The minimum total protein of accessions belonged to Sari accession (table 1).

Proline

The result of proline shown that there were different between prolinefrom different accession and the maximum prolinebelonged to foreign accession (control) and after it's belonged to tall fescue accession from Khoramabad. The minimum prolineof accessions belonged to Sari accession (table 1).

Table1. Amount of Protein, Proline, APX, SOD, CAT and CHL of different Iranian accession and Foreign tall fescue (table 1).

CHL	CAT	SOD	APX	Proline	Protein	Location of accession
2.1	44.1	452	66.5	27.91	33.2	Brojen
2.21	42.8	460	62.6	30.15	31.7	Tiran
2.14	43.7	451	70.9	28.9	30.9	Hashtrod
2.17	42.9	462	72.5	29.41	31.4	Saghez
2.22	43.6	450	71.5	28.4	32.1	Hamedan
2.13	42.1	447	66.4	30.94	30.8	Aligodarz
2.19	42.5	459	64	27.9	30.9	Divandareh
2.21	43.5	445	69.1	28.77	31.3	Alisadr
2.14	44.1	468	69.01	29.61	30.6	Boloran
2.17	44.2	455	71.5	28.92	29.8	Bostanabad
2.12	43.6	453	67.52	28.54	29.9	Golpaygan
2.19	42.8	451	67.3	29.97	30.8	Eslamababd
2.32	42.7	462	66.5	29.72	31.4	Arak
2.22	43.5	440	69.6	30.48	28.8	Kamyaran
2.35	42.6	458	69.8	31.83	32.4	Khoramabad
2.17	44.5	454	68.9	27.95	33.8	Salmas
2.2	42.4	451	70.5	29.12	29.6	Darehsari
2.16	42.8	449	72.1	27.44	30.3	Sanandaj
2.15	41.5	456	69.2	29.99	31.1	Divandareh2
2.3	43.4	455	69.1	30.41	32.7	Pkdasht
2.31	44.5	460	70.05	28.46	31.9	Garmsar
2.27	43.3	350	70.2	30.17	31.4	Shahrod
0.78	37.2	347	52.3	16.41	23.8	Tonekabon
0.96	36.4	344	51.75	16.52	24.1	Manjil
1.01	36.1	344	45.49	17.91	23.9	Azadshahr
0.78	36.9	352	46.31	17.66	24.3	Rasht
0.76	37.2	349	44.78	17.31	23.9	Mahmodabad
0.56	37.5	350	49.26	18.6	24.4	Bandar gaz
2.21	42.6	450	70.55	29.55	31.6	Tehran
0.73	37.5	356	48.7	17.1	23.7	Chalos
0.89	35.2	349	45.6	15.9	24.7	Khoshyeylagh
1.02	35.3	347	47.2	15.2	23.6	Aliabad
2.11	42.9	456	70.71	30.52	33.6	Karaj
0.92	37.1	341	43.59	16.11	23.6	Babol
0.85	35.1	337	45.98	16.7	22.8	Chaboksar
0.7	36.5	348	46.51	15.6	22.1	Sari
0.62	37.1	352	48.73	16.1	27.3	Neka
0.59	36.2	347	49.21	18.2	23.6	Qaemshahr
2.1	42.7	449	71.68	28.63	30.7	Qazvin
0.91	37.1	346	40.7	17.31	22.3	Lahijan
2.21	43.5	470	72.58	29.43	31.5	Kohein
2.29	42.5	356	73.4	27.6	33.4	Semnan
1.2	36.4	350	44.6	16.2	22.6	Gorgan
1.1	39.2	347	49.5	17.4	23.7	Damghan
0.91	37.8	340	48.7	15.8	22.9	Behshahr
3.9	45.4	520	78.34	34.25	34.7	Foreign
0.029	1.25	45.2	4.25	2.74	3.5	LSD (5%)

Peroxidase

The result of peroxidase shown that there were different between peroxidase from different accession and the maximum peroxidase belonged to foreign accession (control) and after it's belonged to tall fescue accession from Saghez. The minimum peroxidase of accessions belonged to Lahijan accession (table 1).

Superoxide dismutase

The result of superoxide dismutase shown that there were different between superoxide dismutase from different accession and the maximum superoxide dismutase belonged to foreign accession (control) and after it's belonged to tall fescue accession from Boloran. The minimum superoxide dismutase of accessions belonged to Chaboksar accession (table 1).

Catalase

The result of catalase shown that there were different between catalase from different accession and the maximum catalase belonged to foreign accession (control) and after it's belonged to tall fescue accession from Garmsar. The minimum catalase of accessions belonged to Khoshyeylagh accession (table 1).

Total chlorophyll content

The result of Total chlorophyll content shown that there were different between Total chlorophyll content from different accession and the maximum Total chlorophyll content belonged to foreign accession (control) and after it's belonged to tall fescue accession from Khoramabad. The minimum Total chlorophyll content of accessions belonged to Sari accession.

DISCUSSION

Proline enrichment in the stressed plants is a general responses to various abiotic stresses, hence it has been developed as effective indices for stress tolerance identification (Abdel-Nasser and Abdel-Aal, 2002; Akram*et al.*, 2007). Moreover, reactive oxygen species (ROS) production has been reached when plant 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 (Quan*et al.*, 2004).

Antioxidant enzymes activity increases in plant cells as a response to environmental stresses. Environmental stresses can result in the production of Reactive Oxygen Species (ROS), including O^- , H_2O_2 and OH^- ; these ROS adversely affect crops yield and quality (Baby and Jini, 2011; Rahimzadeh et al., 2007). ROS are 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 include 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 stress (Sairam and Saxena 2010). Researches on sunflower, sorghum and soybean showed that drought stress increased the activity of superoxide dismutase (SOD), glutathione peroxidase (GPX) and catalase (CAT)(Amman, 2004). Another studies showed that applying 21 g of selenium boosted the catalase activity (Shafei, 2005). Sairam and Saxena(2010) studies on three wheat cultivars indicated that drought stress increased lipid peroxidation and enzymes ascorbate peroxidase, glutathione reductase and peroxidase, but reduced the membrane resistance, chlorophyll and carotenoids.

The result of chlorophyll content showed that the sensitive accession had less content of its. Under the water deficit stress, chloroplast ultra-structures are the first targets to be damaged in the cellular levels 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 effects on the integrity of cell.

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