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Investigations on resistance tall fescue (*Festuca arundinacea* Scherb.) accesstions 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.

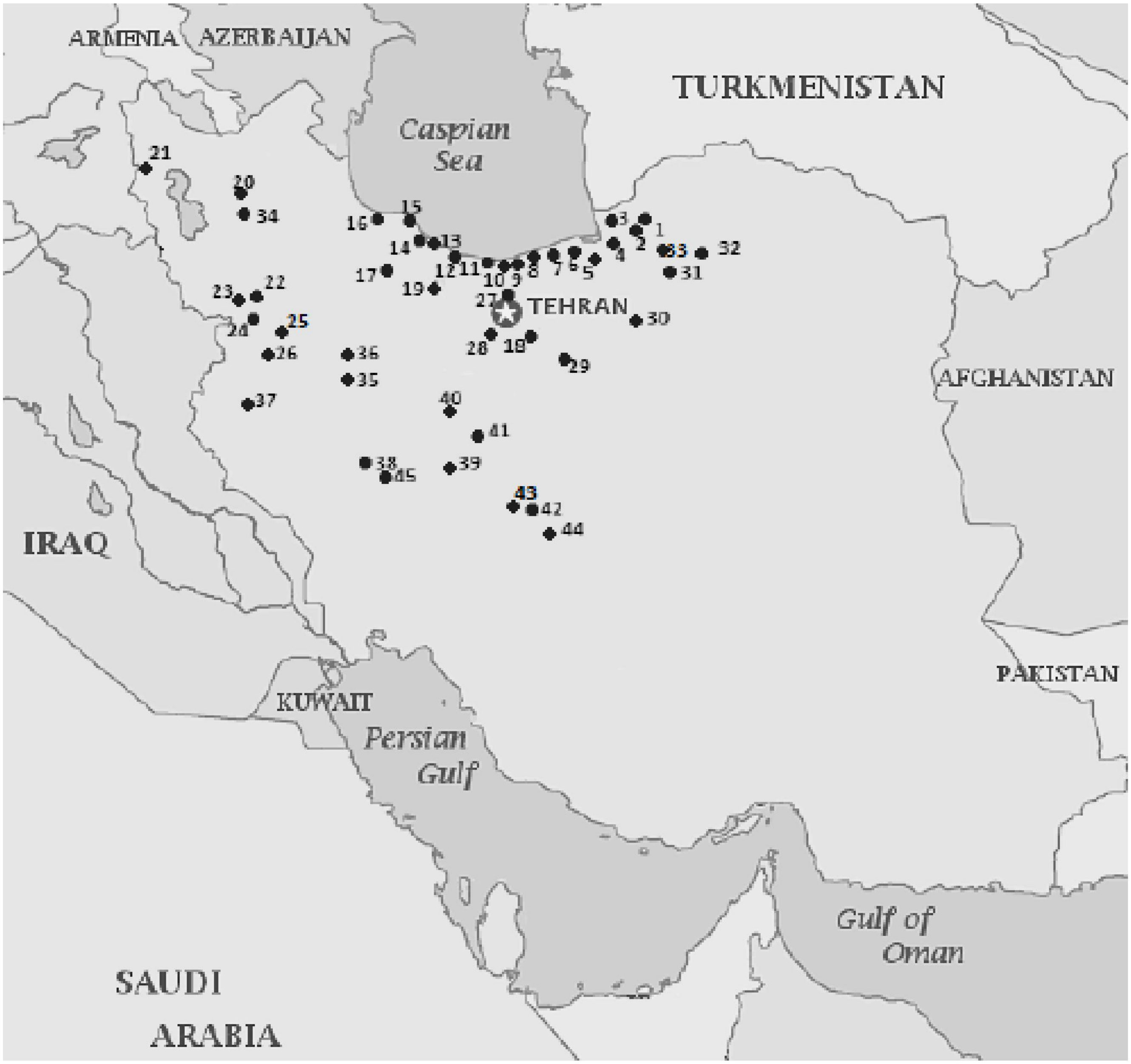
INTRODUCTION

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 turfgrasses whereasheat stress is a limiting factor primarily for cool-season turfgrass growth. Cool-season turfgrass species grow most actively at temperatures ranging from 18°C to 24°C for shoot growth and 10°C to 18°C for root growth, and warm-season turfgrass species are best adapted to warmer climates, commonly having an optimum temperature range of 27°C to 35°C[5]. 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 (*Festuca arundinacea* Schreb.) is better able to avoid drought than other cool-season turfgrasses such as perennial ryegrass (*Lolium perenne* L.) or Kentucky bluegrass (*Poa pratensis* L.), which has been mainly attributed to its extensive and prolific rooting characteristics[8,10,12,16]. Zoysiagrass species (*Zoysia*spp.) are considered as a relatively drought

FULL PAPER

tolerant species within warm-season turfgrasses[6], but may have shallower rooting and thus poor drought avoidance[8,16] 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[9,11]. 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



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.

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

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[7]. 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 (*Festuca arundinacea* Scherb.). Physiological and morphological characteristics were examined.

EXPERIMENTAL

Forty five Iranian accessions and one foreign cultivar (as control) of *F.arundinacea* were collected from different geographical regions (Figure 1) and moved to greenhouse of Department of Horticultural Science in Shiraz University. They were maintained under ambient temperature at 25±2°C, 70-80% relative humidity. Photosynthetic photon flux (PPF) density was set at 60±5 $\mu mol\ m^{-2}\ s^{-1}$ 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.

RESULTS

Total protein

The result of total protein shown that there were different between total protein from different accession

TABLE 1: Amount of Protein, Proline, APX, SOD, CAT and CHL of different Iranian accession and Foreign tall fescue

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

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and the maximum total protein belonged to foreign 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 praline from different accession and the maximum praline belonged 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).

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[1,2]. 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 of unsaturated fatty acids, leading to alter the membrane structure and their properties[17].

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[4]. 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[4]. 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)[4]. These enzymes have key role in the defense against oxidative stress. Studies on barley, wheat, soybean and chickpea determined that the Catalase activity is effective in reducing the damages of stress[19]. Researches on sunflower, sorghum and soybean showed that drought stress increased the activity of superoxide dismutase (SOD), glutathione peroxidase (GPX) and catalase (CAT)[3]. Another studies showed that applying 21 g of selenium boosted the catalase activity[19,20]. 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[14]. An enriched ROS in stressed tissues impairs cellular membrane and organelles which effects on the integrity of cell.

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