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Drought tolerance of turfgrass genetic resources

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Field trials were carried out at the Lithuanian Institute of Agriculture in 2006. The tests involved 120 genotypes of 9 major grass species bred for turf in Lithuania: *Festuca rubra* L. (subsp. *commutata* and subsp. *rubra*) and *Festuca ovina* L., *Poa* L. and *Poa compressa* L., *Agrostis capillaris* L., *Lolium perenne* L., *Koeleria glauc*a DC and *Deschampsia caespitosa* Beauv. A large part of the genetic resources were collected in various natural habitats of Lithuania and other countries (Latvia and Estonia).

The aim of this work was to estimate drought susceptibility of turfgrass species and genotypes.

Experimental findings suggest that drought has a severe adverse effect on the quality of all the turfgrass species tested. After 75 days of drought, the ornamentality of various turfgrass species declined by 58.9% (*Festuca ovina*) to 83.3% (*Deschampsia caespitosa*). According to drought resistance, the test species can be ranked in the following sequence: *Festuca ovina* > *Lolium perenne* = *Poa compressa* > *Poa pratensis* = *Koeleria glauca* > *Festuca rubra* subsp. *Rubra* > *Festuca rubra* subsp. *Commutata* > *Agrostis capillaris* > *Deschampsia caespitosa.*

During the test period, drought resistance of individual varieties or breeding lines was revealed. The most resistant genotypes were identified within each species.

Key words: drought, ornamentality, tolerance, turfgrass

INTRODUCTION

Turfgrass plants need soil moisture to maintain normal growth and development. The ornamental qualities of turf are severely affected by drought. During droughty periods, leaves may die and drop from the plant, although the grasses will generally recuperate upon receiving adequate irrigation.

Some turfgrass species are able to remain green and maintain acceptable turf quality during drought or a low precipitation period due to their root structure, density and relatively low water demand [1–3]. During drought periods, some species pass into dormancy (turn brown) and recover when water is supplied. Efficient recovery from drought may prove it to be more important than plant growth during a dry season because it enables a species to persist in swards or pastures and improve their competition with less drought-resistant species [4, 5]. In Lithuania, the warm period of the year lasts six months. Droughty summers occur on average every five years [6].

A proper choice of drought-resistant turfgrass species intended for turfs on a non-irrigated sloping relief would enable the sward to retain its ornamental characteristics for a longer period during droughts.

The aim of this work was to ascertain drought susceptibility of turfgrass species and genotypes.

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MATERIALS AND METHODS

Objects: 120 genotypes of 9 major grass species bred for turf in Lithuania: 32 *Festuca rubra* (subsp. *commutata* – 15 and subsp. *rubra* – 17) and 20 *Festuca ovina*, 22 *Poa pratensis* and 8 *Poa compressa*, 9 *Agrostis capillaris*, 8 *Lolium perenne*, 5 *Koeleria glauca* and 6 *Deschampsia caespitosa*. A large part of the genetic resources studied were collected in various natural habitats of Lithuania and other countries (Latvia and Estonia).

Variety-testing experiments of turfgrasses were established on a calcareous, gleyic, moderately heavy drained brown soil. The plough layer is 250–300 mm, pH 7.2–7.5, humus 1.9–2.2%, total nitrogen 0.14–0.16%, mobile phosphorus 201–270, potassium 101–175 mg kg^{1} of soil. Fertilisation strategy including N_{150} P_{60} K_{90} was employed annually.

Seeds were sown directly by hand in July 2005 on 6 (2 × 3) m^2 plots. The condition of plants during drought and recovery periods was recorded visually using the following scale: 1 – completely dead plants, no green tissue visible, 3 – traces of green tissue, usually at the base of the youngest leaves, 5 – approximately half of plants with appreciable amounts of green leaves, 7 – most or all of leaves alive, but with most leaves scorched, 9 – all leaves alive without symptoms of scorching.

When the herbage had reached a height of 60–120 mm, all varieties and breeding lines were simultaneously cut at a height of 30 mm.

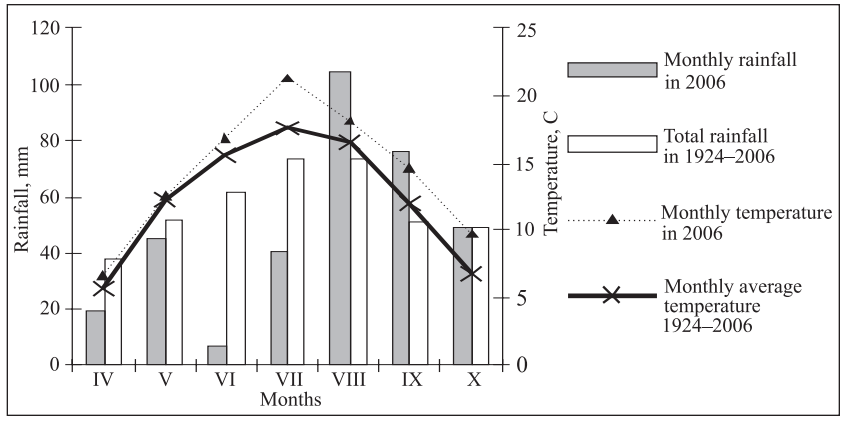

Fig. 1. Long-term (1924–2006) and 2006 growing season climatic conditions in Dotnuva

Table. **Identification of drought-tolerant turfgrass genotypes**

Name of variety, number of breeding line	Origin	Turf quality			
		at the end of drought, points	reduction, %	Recover from the end of drought, %	
				after 10 days	after 20 days
Festuca ovina n = 20					
Ridu	Denmark	5.0	44.5	20.0	100.0
Lėnas	Lithuania	5.0	44.5	20.0	100.0
mean		3.7	58.9	16.2	100.0
Lolium perenne n = 8					
45	Lithuania	3.5	61.1	14.3	100.0
Taya	Denmark	3.0	66.7	16.7	100.0
mean		3.0	66.7	16.7	100.0
Festuca rubra subsp. *commutata* n = 15					
213	Lithuania	2.5	72.2	20.0	87.5
mean		2.0	77.8	15.0	86.8
Festuca rubra subsp. *rubra* n = 17					
Gludas	Lithuania	5.0	44.5	49.3	100.0
mean		2.2	75.6	45.5	100.0
Agrostis capillaris n = 19					
Verknė	Lithuania	2.0	77.8	25.0	88.2
mean		1.7	81.1	29.4	70.1
Poa pratensis n = 22					
Aluona	Lithuania	5.0	44.5	33.3	100.0
mean		2.8	68.9	35.7	100.0
Poa compressa n = 8					
Smiltė	Lithuania	3.5	61.1	14.3	100.0
mean		3.0	66.7	16.7	100.0
Koeleria glauca n = 5					
2060	Lithuania	3.0	66.7	33.3	100.0
mean		2.8	68.9	42.9	100.0
Deschampsia caespitosa n = 6					
253	Lithuania	1.5	83.3	33.3	91.7
mean		1.5	83.3	20.0	92.7
Mean of experiments		2.5	72.2	27.2	93.3
LSD_{05}		0.12			

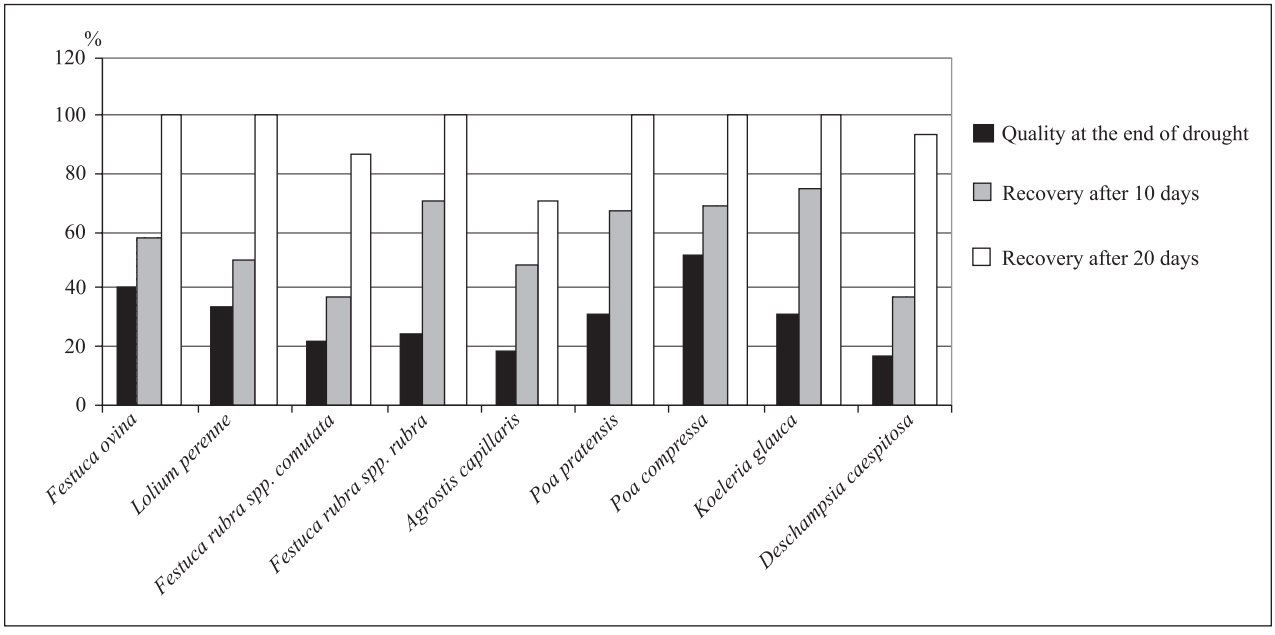

Fig. 2. Turf quality of 9 grass species under 2006 drought conditions

The general description of climatic conditions during the growing season of 2006 in Dotnuva was compared with the respective long-term (1924–2006) values.

In 2006, the growing season (April–October) was by 1.7°C warmer than normal (Fig. 1).

During April–October, the mean temperature was 14.3 °C (norm 12.6 °C) and total rainfall was 341.6 mm (norm 399.4 mm). The hydrothermal coefficient (HTC) was as low as 1.1 (for the period with temperatures above 10 °C). Especially droughty was June (rainfall 6.8 mm, HTC = 0.1) and the first two ten-day periods of July (15.2 mm, HTC = 0.3). The drought lasted 75 days – from May 30 to August 13. Although there were 25 days with rainfall during this period, the total rainfall amounted to 68.6 mm. The HTC was 0.5. Since August 14, when 34.6 mm of rainfall fell, the state of turfgrasses started to improve. The date of August 14 was considered to be the end of the drought.

RESULTS AND DISCUSSION

Tests of drought tolerance of the eight turfgrasses revealed that within the species separate varieties and breeding lines responded differently to drought (Table).

The most drought-tolerant genotypes were identified within each species. The different drought response of separate varieties and breeding lines can be explained by the diversity of morphological characteristics (different leaf width and root system) [7–9].

Experimental findings suggest that drought has a severe adverse effect on the quality of all the turfgrass species tested. After 75 days of drought, the ornamentality of various turfgrass species declined by 58.9% to 83.3% (Fig. 2).

Festuca ovina, Lolium perenne and *Poa compressa* were the best to withstand the effects of long-term drought. The ornamentality of their herbage made up on average 41.1 and 33.3% as compared with the state of the sward before the drought (100%). The worst damaged swards were *Agrostis capillaris and Deschampsia caespitosa*, their ornamentality being 18.9 and 16.7%, respectively. According to the ornamentality, in the conditions of long-term drought the species tested by us were ranked in the following sequence: *Festuca ovina* > *Lolium perenne* = *Poa compressa* > *Poa pratensis* = *Koeleria glauca* > *Festuca rubra* subsp. *rubra* > *Festuca rubra* subsp. *commutata* > *Agrostis capillaris* > *Deschampsia caespitosa*.

Similar results were obtained in turfgrass tests conducted abroad for drought tolerance during the summer season [8, 10]. Grzegorz Žurek [10] reports that *Lolium perenne, Festuca rubra* subsp. *rubra and Festuca ovina* are plants that partly remain green during drought and are capable of medium fast recovery after water supply. Minner and Butler [8] indicate that *Lolium perenne* is less sensitive to drought than *Poa pratensis*. Abraham [11] suggests that *Poa pratensis* is moderately to low drought tolerant.

According to sward quality recovery after rain, *Festuca rubra* subsp. *rubra, Koeleria glauca* and *Poa pratensis* were the fastest to respond to rainfall (Fig. 2).

Such species as *Deschampsia caespitosa* and *Agrostis capillaris* did not recover even 20 days after rain. As Ruemmele et al. [12] have reported, the drought tolerances of *Agrostis capillaris* is considered poor to fair. Experiments done in Poland also demonstrated a slow recovery of *Deschampsia caespitosa* plants after drought [10].

CONCLUSIONS

1. The turfgrass species and genotypes tested exhibited a different response to drought.

2. According to sward ornamental qualities as affected by exposure to a long-term drought, the species tested were ranked in the following sequence: *Festuca ovina* > *Lolium perenne* = *Poa compressa* > *Poa pratensis* = *Koeleria glauca* > *Festuca rubra* subsp. *rubra* > *Festuca rubra* subsp. *commutata* > *Agrostis capillaris* > *Deschampsia caespitosa.*

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VEJŲ ŽOLIŲ GENETINIŲ IŠTEKLIŲ TOLERANTIŠKUMAS SAUSRAI

Santrauka

Lauko bandymai buvo vykdomi Lietuvos žemdirbystės institute 2006 metais. Tirtos 9 pagrindinės žolių rūšys, selekcionuojamos Lietuvoje vejų įrengimui: *Festuca rubra* L. (subsp. *commutata* ir subsp. *rubra*) ir *Festuca ovina* L., *Poa pratensis* L. ir *Poa compressa* L., *Agrostis capillaris* L., *Lolium perenne* L., *Koeleria glauca* DC ir *Deschampsia caespitosa* Beauv. Vejų žolių kolekciją sudarė 120 genotipų, iš kurių didžiausia dalis – laukiniai ekotipai, surinkti natūraliose augimvietėse Lietuvoje ir kitose šalyse (Latvijoje, Estijoje). Bandymų duomenys rodo, kad 2006 m. sausra turėjo neigiamos įtakos visų tiriamų žolių rūšių dekoratyvumui. Po 75 dienų sausringo periodo vejų dekoratyvumas sumažėjo nuo 58,9% (*Festuca ovina* L.) iki 83,3% (*Deschampsia caespitosa*). Pagal tolerantiškumą sausrai tiriamos rūšys išsidėstė šia seka: *Festuca ovina* > *Lolium perenne* = *Poa compressa* > *Poa pratensis* = *Koeleria glauca* > *Festuca rubra* subsp. *rubra* > *Festuca rubra* subsp. *commutata* > *Agrostis capillaris* > *Deschampsia caespitosa.* Kiekvienoje tirtoje rūšyje buvo išaiškinti tolerantiškiausi sausrai genotipai.