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Evaluation of red fescue turfgrass accessions in genetic collection

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Experiments with 25 accessions of red fescue (*Festuca rubra* L.) were carried out at the Lithuanian Institute of Agriculture in Dotnuva in 2003–2004.

The red fescue accessions differed in earliness, spring regrowth, bush diameter, inflorescence abundance, plant height and herbage yield.

Most of the red fescue local populations were found not to possess the morphological traits and biological characteristics valuable for turf grass breeding.

Tall-growing, wide-leaved, thin-bush forming plants of forage type predominated. Genetic resources of red fescue can be used as initial material for the breeding of new varieties. Cluster analysis revealed six groups of accessions differing in a number of characters.

Key words: *red fescue*, genetic resources, cluster analysis

INTRODUCTION

More than 10 species of turfgrass are cultivated in Lithuania. Red fescue (*Festuca rubra* L.) is a perennial rhizomatous grass which due to its biological properties is able to adjust well to various soil and adverse climatic conditions. Red fescue is the most widely used fine fescue for turf grass purposes. It moves laterally through rhizomes, which makes it unique amongst the fine fescue family. It exhibits a good shade and drought tolerance and is best sown as a companion to other grasses in a blend. Red fescue can be utilized in golf course surrounds, tees and fairways, as well as lawns, cemeteries, parks and the like [1]. Tolerance to toxic atmospheric gases has evolved red fescue varieties used for urban parks and recreation [2].

Conservation of genetic resources of turfgrasses was started in Lithuania in 1994, in cooperation with Nordic–Baltic countries, when the Lithuanian Plant Gene Bank was organized [3]. In 1995–2005, plant breeders of the Lithuanian Institute of Agriculture arranged 16 collecting trips in different geographical locations of various parts of Lithuania and Kaliningrad Region (Russia). Now the collection of red fescue includes more than 400 accessions of wild populations, advanced cultivars and breeding lines. All the samples were multiplied, and their morphological characters and biological properties were studied. The objective of the present work was to establish a genetic collection of red fescue, to evaluate it and to select genetically valuable genotypes.

MATERIALS AND METHODS

Experimental materials included four red fescue cultivars, seven wild populations and 14 breeding lines. The breeding lines were developed at the Lithuanian Institute of Agriculture by the method of individual selection from wild populations. The experiments were carried out during 2002–2003 in Dotnuva on a sod gleyic moderately heavy drained loam soil with a pH value in the arable layer varying from 6.4 to 7.2 and humus content from 1.9 to 2.2%. Experimental plots were planted with the plants of red fescue populations grown in the greenhouse in 2002. The seeds were collected in Lithuania during expeditions arranged over the period 1999–2001. The cultivars were obtained from the Vavilov All-Russian Plant Production Institute.

Grasses were sown in 2002 after black fallow. Soil in the year of sowing was cultivated and harrowed. In the autumn of each year of use, phosphorus and potassium fertilizers ($P_{60}K_{90}$) were applied. Nitrogen fertilizers (N_{90}) were applied each year of herbage utilization in several applications: in spring N_{45}, and N_{45} after the first cut. In each population, 20 plants were planted at a distance of 50 × 50 cm. The standard variety ‘Gludas’ was planted in five fields. Evaluations were made on a 9-point scale [4]: one point – a very low and nine points – a very high value of a character or property. The following abbreviations were used in the table: AC – advanced cultivar, BL – breeding line, WP – wild population.

Meteorological conditions in 2003–2004 were diverse. In 2003 the winter was cool. The spring was late and dry and the summer was dry and warm as well. In 2004 the winter was mild. The spring was early and dry, but the summer was rather rainy and warm. In 2004, meteorological conditions were more favorable for plant growth and development.

Differences among accessions were tested by one-way analysis of variance (ANOVA) [5]. The hierarchical cluster analysis dendrograms were based on agglomerative grouping using Ward's method and the single linkage between groups clustering method using Euclidean distances [6].

RESULTS AND DISCUSSION

Earliness. There were more differences as for this feature (1 to 9 points) among the accessions of red fescue. Very early accessions (1 point) were the cultivar 'Napoli' and the breeding line 212. Early accessions (3 to 4 points) were the breeding lines: 194, 213, 221, 222 and the wild population 335. Medium accessions (5 to 6 points) were the breeding lines 195, 199, 206 and the wild populations 329, 330, 331. Late accessions (7 to 8 points) were the cultivars 'Gludas', 'Diego', breeding lines 223, 224, wild population 333. Very late accessions (>8 points) were the breeding lines 184, 192 and 226 (Table).

Wintering. Red fescue is characterized by good overwintering. The plants were evaluated for this trait after the winter of 2002/2003, which was less favorable for wintering. The majority of accessions overwintered well. More severely affected by frost were the breeding lines 220 and 224 developed from Kelmë district wild forms. The level of damage of these accessions was 3 points.

Regrowth in spring. There were small differences as for this feature in the accessions of red fescue. The majority of them exhibited good regrowth. Regrowth was less intensively (7.5 points) in the breeding line 226 and cultivar 'Corina'.

Bush habit. The variation in bush habit of the studied red fescue accessions was not high. most of the accessions were erect. Only the breeding lines 192, 194, 226 and the cultivar 'Gludas' had a semi-prostrative habit of bush.

Density of bush. The majority of the accessions had a high (7 points) density of bush. Among red fescue accessions, only the cultivar 'Corina', breeding lines 199, 206, 221 as well as the wild popula-

Table. **Morphological characteristics and biological properties of different accessions of red fescue**

Accession designation	Status of accession	Regrowth in spring	Earliness	Habit	Herbage yield of		Density of bush	Winter damage	Plant height	Abundance of inflorescences
					first cut	second cut				
Gludas	AC	9	6.5	3	5.5	6	7	1	7	5
Diego	AC	9	7	3	7	7	7	1	7	7
Napoli	AC	8.5	1	3	9	7.5	7	2	8.5	7
Corina	AC	7.5	2.5	1	8	5.5	6.5	1	9	9
184	BL	8.5	8.5	1	8	7	7	1	8	9
192	BL	9	8.5	4.5	5.5	7	7	1	7	5
194	BL	9	3	1	8.5	7	6	1	9	9
195	BL	9	6	1.5	9	6.5	7	1	9	8.5
199	BL	9	5.5	1	7.5	7	6.5	1	8.5	9
206	BL	9	5	1.5	9	6.5	6	1	9	8.5
212	BL	9	1	3	7.5	7	7	1	9	7
213	BL	9	3	1	8.5	7	7	1	9	7
220	BL	8.5	2.5	1	8.5	5	7	3	8.5	8
221	BL	9	3	1	8	6.5	6	2	8.5	6.5
222	BL	9	3.5	1	9	7	7	1	9	9
223	BL	8.5	7	1	7.5	5	7	1	9	8.5
224	BL	9	7	1	8.5	5	7	3	7.5	9
226	BL	7.5	8.5	3	5	5.5	7	2	5	4
329	WP	9	5	1	8.5	7	6.5	2	9	8.5
330	WP	8.5	5.5	1	8.5	7	7	2	8.5	9
331	WP	9	5.5	1.5	9	7	7	1	8.5	8.5
332	WP	9	2.5	1	9	6.5	7	1	9	8.5
333	WP	9	7.5	1	8.5	7	7	2	8.5	9
334	WP	8.5	2.5	1	9	8.5	6	1	9	9
335	WP	9	3	1	7	7	7	2	8.5	7
LSD_{05}		0.76	0.93	0.58	0.91	0.81	1.12	0.92	0.79	1.08

tions 329 (collected from Joniðkis district) and 324 (collected from Ðilalë district) had a lower (6 to 6.5 points) density of bush.

Herbage yield of first and second cuts. The new turfgrass cultivar should have a low herbage yield. Most of the study accessions produced a herbage yield significantly exceeding a standard. Only the breeding line 226 had a herbage yield (sum of first and second cuts 10.5 points) significantly lower than standard (11.5 points).

Plant height. In the majority of the accessions the plants were high (8.5 to 9 points).

As an initial material for breeding, the new turf cultivars of red fescue are close to more shortish forms and have narrower leaves. The breeding line 226 had the lowest plant height (5 points) and narrower leaves.

Abundance of inflorescences. The populations collected in Lithuania and the breeding lines selected from them were rather seedy. Most plants were assessed by 8 to 9 points according to the abundance of inflorescences. Plant height is generally related to the abundance of inflorescences. Shorter plants tend to form fewer inflorescences. A good example here could be the breeding line 226 selected from a wild ecotype collected along the Ringuva riverside near Šiauliai.

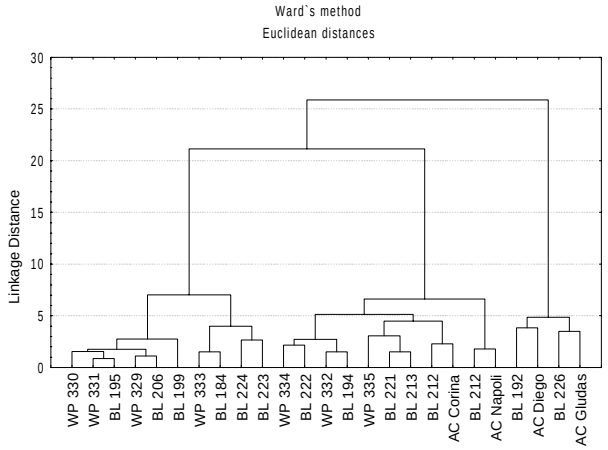

Figure. The dendrite of red fescue accessions (data average for 2003–2004).
AC – advanced cultivar, BL – breeding line, WP – wild population

All the nine investigated characters were used for cluster analysis. Results of the cluster analysis of accessions as a dendrite are shown in Figure. As a measure of the genetic divergence for highlighting close populations, Euclidean distance, a special case of Mahalanobis distance, is used.

For division of the red fescue accessions into groups, Euclidean distance below 5 was taken. Altogether, six groups of accessions precisely distinguishing at this level were secured.

The first group includes medium-ripening accessions (wild accessions: 329, 330, 331; breeding lines: 195, 199, 206) whose plants show good growth in spring, have an erect habit and give a high yield of the first cut.

The second group includes late-ripening accessions (breeding lines: 184, 223, 224 and wild populations 333) whose plants show bad growth in spring, have an erect habit, and produce a higher number of inflorescences.

The third group includes early-ripening accessions (wild populations: 332, 334; breeding lines: 194, 222); they have an erect habit, medium density of bush and very high plants.

The fourth group includes early-ripening accessions (cultivar 'Corina', breeding lines 213, 220, 221 and wild population 335), with an erect habit, medium density of bush and very high plants and a small quantity of inflorescences.

The fifth group includes very early-ripening accessions (cultivar 'Napoli' and breeding line 212), whose plants have a semi-erect habit, big height of plant and a small number of inflorescences.

The sixth group includes very late-ripening accessions (cultivars 'Gludas' and 'Diego'; breeding lines 192, 226), whose plants have a medium growth in spring, a medium habit, short plant height and medium number of inflorescences.

The first and second groups included most of the wild populations and several breeding lines that had high evaluation scores of the following traits: plant height, abundance of inflorescences, and high herbage yield of the 1st and 2nd cuts. These traits are specific of forage-type plants. As donors they would suit for the development of forage-type cultivars.

The other plant type (turf) is characterized by short-growing, medium-yielding, a prostrate bush form, and dense bush forming plants. This group included only two breeding lines, 192 and 226. Among local populations it is difficult to find the ones that would be suitable for lawns in terms of all characteristics and, besides high turf quality, would produce a high seed yield and would be resistant to foliar diseases. As a result, wild populations are used as donors of individual traits in the development of turf-type varieties. This was a conclusion reported by other researchers [7, 8] who use individual selection as the chief breeding method and local populations as breeding material [1, 9–11].

In general, wild populations were high-yielding. The breeding lines developed by the individual selection method from local wild populations lagged behind in terms of productivity. This can be explained by the fact that the breeding lines were developed in the direction of lawn type. From the viewpoint of genetic resources storage, the most valuable wild populations would be Nos. 330, 333, 334, 335, and breeding lines 192, 194, 195, 206, 213, 226. Of the breeding lines suitable for lawns, worth mentioning are No. 226 (selected from a population found

near Smalininkai) and 192 (selected from a population found near Livintai). Of the wild populations, the most suitable one was No. 335 found near the Ringuva river close to Gedinèiai settlement. The plants were short-growing, produced a low herbage yield and re-grew slowly between cuts. For the development of forage-type cultivars, the most suitable wild populations could be Nos. 330 (Joniðkis distr. Þagarë cemetery), 333 (Akmenë distr., Kamanai reserve) and 334 (Akmenë distr., the Venta banks near Skamaièiai settlement). Of the breeding lines, worth mentioning are Nos. 194 (selected from a population found in Varëna distr. near Merkinë), 195 (selected from a population found in Varëna distr., on the Ûla banks near Marcinkonys), 206 (selected from a population found in Juodkrantë on the Raganos mound), 213 (selected from a population collected in Rietas park). The above-mentioned wild populations and breeding lines were tall-growing and produced a high herbage and seed yield. Moreover, the wild population No. 332 and the breeding lines 212, 221, differing in earliness, as well as the breeding line 184 characterised by late-maturity will be stored in the gene bank.

CONCLUSIONS

1. Wild ecotypes of red fescue were distinguished for the diversity of traits and characteristics tested.

2. Most of the tested red fescue local populations were found not to possess the morphological traits and biological characteristics valuable for turf grass breeding.

Tall-growing, broad-leaved, thin-bush forming plants of forage type predominated.

3. On the basis of red fescue local populations formed in Lithuania's territory, te promising breeding lines 192 and 226 suitable for lawns were developed using individual selection.

4. The wild populations Nos. 330, 333, 334, 335 and breeding lines 192, 194, 195, 206, 213, 226, most valuable from the genetic resources storage point of view, have been transferred to the Lithuanian Plant Gene Bank.

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P. Tarakanovas, J. Kanapeckas

RAUDONØJØ ERAIÈINØ GENETINËS KOLEKCIJOS ÁVERTINIMAS

Santrauka

2003–2004 m. LÞI selekciniuose augynuose buvo tirtos 4 veislës, 14 selekciniø linijø, sukurtø individualios atrankos metodu pradinës selekcinës medþiagos pagrindu naudojant vietines laukines raudonøjø eraièinø populiacijas, ir 7 raudonøjø eraièinø laukiniai ekotipai. Nustatyta didelë tirtø pavyzdþiø ávairovë pagal augalø ankstyvumà, atþëlimà pavasará, þiedynø gausumà, augalø aukðtá bei þolës derliø. Dauguma iðtirtø raudonøjø eraièinø laukiniø populiacijø nepasiþymëjo vejø þoliø selekcijai vertingais morfologiniais poþymiais ir biologinëmis savybëmis. Vyravo aukðtaûgiai, plaèialapiai, bei retà kerà formuojantys paðarinio tipo augalai. Pagal minëtus poþymius iðtirti raudonøjø eraièinø pavyzdþiai gali bûti naudojami kaip pradinë selekcinë medþiaga. Klasterine analize buvo nustatytos 6 tarpusavyje besiskirianèios grupës, sujungtos pagal panaðius poþymius grupës viduje.