Development of Meadow Fescue Late Breeding Material Based on Local Populations
Vēlīna selekcijas materiāla izveidošana no pļavas auzenes vietējām populācijām

Juozas Kanapeckas
Lithuanian Institute of Agriculture, e-mail: kanapeckas@lzi.lt
Lietuvas Zemkopības institūts, e-pasts: kanapeckas@lzi.lt

Abstract. Field trials with a view to studying local populations of meadow fescue (*Festuca pratensis* Huds.) were carried out at the Lithuanian Institute of Agriculture in Dotnuva in 2001-2002. Investigations of the earliness of wild local populations showed that meadow fescue, as a species, was very homogeneous in this respect. There was only a two-day difference between the earliest and latest heading dates of the populations. The greatest difference in earliness of individual plants within the population was only 6 days. Early-heading plants dominated (65.25%). Late plants accounted for as little as 0.92%. The presence of late plants in wild populations enables to consider possibility to select late meadow fescue breeding material. The correlation between earliness and herbage yield of the first cut, as well as between earliness and number of floral shoots, the abundance of which determines the yield of first cut, was negative. All this encumbers development of late and productive varieties of meadow fescue.
Key words: meadow fescue, earliness, correlation, selection.

Introduction

Meadow fescue (*Festuca pratensis* Huds.), as a species, is widely used as one of the more important components when composing grassland and pasture mixtures. Compared with the other grasses most widely grown in grasslands and pastures, meadow fescue performs better in terms of overwinter survival than perennial ryegrass, and according to herbage intake surpasses cocksfoot (Neff and Simon, 1985; Brencienė, 1995; Paplauskienė and Sliesaravičienė, 1997). According to the rhythm of development, meadow fescue is attributed to the group of medium early grasses (Lemežienė et al., 1998), which makes it less suitable for mixtures with legumes. The currently Lithuania-grown two high-yielding but early meadow fescue varieties 'Dotnuva I' and 'Kaita' do not solve this problem (Kanapeckas, 1996). In the breeding process of meadow fescue it is very important to produce varieties that combine late-maturity and high-yielding potential. This is very hard to achieve for two reasons: 1) the earliness of naturally growing meadow fescue fluctuates only for about a week, 2) late breeding lines of meadow fescue are characterized by a poor yield. Search for high-yielding initial breeding material differing in the rhythm of development is a very significant chain in meadow fescue breeding. Local wild populations could be of great value, since growing in natural conditions for a number of years they become most hardy and persistent. In many countries selection of local populations is considered as one of the key methods in lawn grass breeding (Skirde, 1967; Корьюс, 1977; Будин, 1979; Лаптев, 1983; Wadington et al., 1992). This method is being successfully applied in forage and lawn grass breeding in Lithuania.

Materials and Methods

Experiments for testing meadow fescue populations were established in the grass breeding crop rotation fields in 2000. The soils of the experimental site are described as calcareous gleyic medium-heavy drained brown soils with the following characteristics of the plough layer: pH – 7.2–7.5, humus content – 1.9–2.2%, total nitrogen – 0.14–0.16%, P_2O_5 –201–270, and K_2O – 101–175 mg kg^{-1} of soil. The preceding crop was black fallow. $N_{150}P_{120}K_{180}$ fertilizer was applied. Phosphorous and potassium fertilizers were applied in the year of sowing after soil levelling. Nitrogen fertilizer was applied in the year of use in several applications: N_{60} in spring and N_{45} after 1st and 2nd cut. Experimental plots were planted with plants from 12 populations, collected in Lithuania in 1999 according to international methodology and grown in the greenhouse (Table 1). A total of 100 plants of each population were transplanted at 50 x 50 cm distances. All plants of each population were estimated for the following morphological characteristics and biological properties: overwinter survival, re-growth in spring and after cuts, number of days from the start of growing season to heading, plant height at harvesting, herbage yield, bush shape and diameter, leaf width and color, uniformity of emergence of inflorescences, their length and abundance, and disease inci-

Table 1

Collecting site of wild populations of meadow fescue

LIA catalogue No.	Collecting site			
	location	latitude, degrees	longitude, degrees	elevation, m
3975	2.0 km W of Paberže	55°31'N	23°56'E	72
3976	0.1 km S of Paberže	55°30'N	23°58'E	67
3977	1.0 km S of Paberže	55°30'N	23°58'E	66
3978	1.5 km SE of Užupe	55°30'N	23°59'E	69
3979	1.0 km SW of Vaidatoniai	55°23'N	23°59'E	60
3980	4.0 km W of Truskava	55°27'N	24°13'E	57
3981	2.6 km NW of Truskava	55°28'N	24°13'E	59
3982	5.0 km SW of Kruonis	54°45'N	24°15'E	85
3983	8.0 km SE of Stakliškes	54°34'N	24°28'E	180
3984	0.8 km NW of Aukštadvaris	54°35'N	24°33'E	185
3985	6.0 km SW of Aukštadvaris	54°33'N	24°33'E	138
3986	8.0 km SW of Aukštadvaris	54°33'N	24°32'E	136

dence. A 9 point scale system was used for assessment: 1 – very low, 9 – very high value of the characteristics (Tyler, 1987). Grasses were investigated during 2001–2002. In the year of use, herbage was cut twice. The first cut was taken at full heading stage of each population, the second – after 40–50 days. The coefficient of correlations between morphological and biological traits of each population was estimated. The data were processed by statistical methods (Brewbaker, 1996; Tarakanovas, 1999).

Research Results

Experimental objectives were:

1) to investigate variations in the rhythm of development between individual populations and within Lithuania-collected wild populations;

2) to determine the relationship between earliness and yield;

3) to select late, high-yielding plants for further breeding work.

Investigations of meadow fescue wild populations collected in Kėdainiai, Kaišiadorys and Trakai districts suggest that the difference in earliness among all collected populations was insignificant. Average earliness of meadow fescue plants was estimated from 1.88 to 3.91 points (Table 2). Population No. 3976 started heading at the earliest date. Average earliness of the in-

Table 2

Earliness of wild populations of meadow fescue, in points

No. of the population	Per cent of plants in various assessment groups									average point
	early			medium early			late			
	1	2	3	4	5	6	7	8	9	
3975	30	28	22	11	9	0	0	0	0	2.41
3976	46	35	8	7	4	0	0	0	0	1.88
3977	26	35	21	10	8	0	0	0	0	2.39
3978	22	45	16	10	7	0	0	0	0	2.35
3979	8	21	21	10	23	13	4	0	0	3.74
3980	16	27	22	15	9	8	3	0	0	3.10
3981	13	28	44	9	6	0	0	0	0	2.67
3982	7	13	32	14	29	5	0	0	0	3.60
3983	5	16	29	14	25	8	3	0	0	3.74
3984	6	7	46	12	26	3	0	0	0	3.54
3985	2	4	37	18	36	3	0	0	0	3.91
3986	2	6	37	15	37	2	1	0	0	3.89
Average of the experiment	15.3	22.1	27.9	12.1	18.3	3.5	0.9	0	0	3.10
LSD_{05}										0.050

Table 3

Major morphological characteristics and biological properties of meadow fescue wild populations

No. of the population	Characteristics and traits, points			
	herbage yield	earliness	shape of bush	abundance of inflorescences
3975	7.48	2.41	5.63	6.11
3976	7.84	1.88	3.62	8.01
3977	7.71	2.39	3.11	7.67
3978	7.07	2.35	4.02	7.07
3979	6.18	3.74	6.39	6.47
3980	6.29	3.10	7.05	5.91
3981	5.46	2.67	5.80	6.02
3982	6.15	3.60	3.88	5.34
3983	5.81	3.74	6.20	4.99
3984	5.46	3.54	7.87	5.20
3985	5.90	3.91	6.35	5.45
3986	4.30	3.89	7.64	4.59
Average of the experiment	6.31	3.10	5.54	6.07
LSD_{05}	0.066	0.050	0.081	0.088

vestigated plants of this population was estimated at 1.88 points. There was a two-day difference between the populations that started heading at the earliest date (population No. 3976) and at the latest date (populations Nos. 3985 and 3986). Assessment of plant earliness within populations revealed plants with different earliness. The investigated populations contained 65.3% of early plants, 33.8% of medium early plants, and as little as 0.9% of late plants. The highest number of early plants was found in population No. 3976 (89%), the lowest number – in population No. 3985 (43%). Most populations were dominated by plants whose range of earliness was up to 4 days. Populations Nos. 3979, 3980 and 3983 were an exception. Plants of these populations later than 4 days accounted for 17%, 11%, and 11%, respectively. However, late plants of meadow fescue, as a rule, are noted for poor yield (Table 3). This is confirmed by a weak negative correlation (0.015–0.268) established between these characteristics (Table 4). Herbage yield of the first cut of early population No. 3976 was estimated at the highest point (7.84). The latest populations Nos. 3983, 3985 and 3986 were of low or medium productivity. Their productivity was estimated at 5.81, 5.90 and 4.30 points, respectively. Furthermore, herbage yield was directly dependent on the abundance of floral shoots. A strong positive correlation (0.689–0.875) was determined between these characteristics.

The abundance of floral shoots correlated with earliness. This is demonstrated by the weak correlation (0.037–0.304) established between them. Out of the 12 investigated wild populations of meadow fescue collected in different locations, the abundance of inflorescences of earliest population No. 3976 was estimated at the highest point, 8.01, while that of late populations Nos. 3983, 3985 and 3986 – at 4.99, 5.45 and 4.59 points, respectively. Later populations of meadow fescue, apart from producing lower herbage yield, will produce a lower seed yield due to the lower number of floral shoots. Moreover, a relationship was determined between the abundance of floral shoots and bush shape. Weak and medium strong negative

Table 4

Coefficients of correlation between main morphological and agronomically valuable characteristics of wild meadow fescue populations

Properties	Coefficients of correlation
Herbage yield of 1st cut x earliness	-(0.015±0.102-0.268±0.097)
Herbage yield of 1st cut x abundance of inflorescences	0.689±0.074-0.875±0.049
Abundance of inflorescences x earliness	0.037±0.101-0.304±0.097
Abundance of inflorescences x shape of a bush	-(0.206±0.099-0.672±0.075)

Table 5

Coefficients of genotypic variation between main agronomically valuable characteristics of wild meadow fescue populations, 2001-2002

Properties	Coefficient of genotypic variation (CVg), %	
	2001	2002
Earliness	21.21	24.28
Abundance of inflorescences	20.13	15.57
Shape of a bush	27.03	26.15
Herbage yield of 1st cut	17.97	15.68

correlation (0.206–0.672) established between these parameters suggests that the more trailing is the bush, the fewer floral shoots it forms. The data presented in this paper show that trailing bush shape, low or medium number of floral shoots, and, resulting from this, lower herbage and seed yield were characteristic of late populations.

The determined genotypic coefficient of variation (CVg) confirmed the main principles of foreign investigations that a sufficient diversity of morphological characteristics and biological properties exists not only between populations of meadow fescue but also within a population (Фунтова, 1999; Гречушкина-Сухорукова, 1999; Casler and Van Santen, 2000) (Table 5). The presence of late plants in wild populations enables to consider possibility to select initial breeding material of late meadow fescue. Thus, local populations could be used as initial material for the development of new varieties.

Conclusions

1. Investigations of the earliness of wild local populations showed that meadow fescue (*Festuca pratensis* Huds.), as a species, was very homogeneous in this respect.

2. The correlation between earliness and herbage yield of the first cut, as well as between earliness and the number of floral shoots was negative.

3. The presence of late plants in wild populations enables to consider selection of late meadow fescue initial breeding material.

References

1. Brencienė, V. (1995) Comparison of cereal grasses in the western part of Lithuania. *Agriculture,* 46, 16–22.

2. Brewbaker, J. L. (1996) *Quantitative genetics on a spreadsheet*. University of Hawaii, Honolulu, 163 pp.

3. Casler, M. D., Van Santen, E. (2000) Patterns of variation in a collection of meadow fescue accessions. *Crop Science,* 40, 1, 248–255.

4. Kanapeckas, J. (1996) Meadow fescue 'Kaita'. *Agriculture,* 54, 190–196.

5. Lemežienė, N., Kanapeckas, J., Tarakanovas, P., Nekrašas, S. (1998) Productivity of perennial grasses and some other agronomically valuable characteristics. *Agricultural Science*, 1, 42–47.

6. Neff, R., Simon, U. (1985) Zum Einfluss von Entwicklungsstabium und Probeunahmetermin auf *in vitro* Verbaulichkeit und Rohproteingeholt von Wiesenlischgrosholmen. *Wirtschafscigene Futten*, 31, 2, 93–104.

7. Paplauskienė, V., Sliesaravičienė, L. (1997) Analysis of chemical composition of perennial ryegrass and meadow fescue grass. *Agriculture,* 57, 209–218.

8. Skirde, W. (1967) Rasengräserzüchtung un Rasengräserprüfung in Holland und Belgien. *Der Rasen*. Bernhausen, 5, 1–10.

9. Tarakanovas, P. (1999) *Statistinių duomenų apdorojimo programų paketas 'Selekcija'*. Akademija, 57 pp.

10. Tyler, B. (ed) (1987) Collection, characterization and utilization of genetic resources of temperate forage grass and clover. In: *International board for plant genetic resources*, IBPGR, Rome, 65 pp.

11. Wadington, D. V., Carrow, R. N., Shearman, R. C. (1992) *Turfgrass*. Madison, Wisconsin USA, 765 pp.

12. Будин, К. З. (1979) *Селекция растений в Скандинавских странах*. Л., 174 с.

13. Гречушкина–Сухорукова, Л. А. (1999) Экологическая изменчивость дикорастущих популяций кормовых трав как основа исходного материала для адаптивной селекции. В кн.: *Эколого–популяционный анализ кормовых растений естественной флоры, интродукция и использование*. Сыктывкар, 47–49.

14. Корьюс, Х. (1977) *Улучшение и рациональное использование травостоев в Белоруссии, Эстонии, Латвии и Литве*. Вильнюс, 110 с.

15. Лаптев, А. А. (1983) *Газоны*. Киев: Наукова думка, 176 с.

16. Фунтова, В. Г. (1999) Эколого–морфологическая изменчивость *Festuca pratensis* Huds. в различных типах местообитаний реки луги. В кн.: *Эколого–популяционный анализ кормовых растений естественной флоры, интродукция и использование*. Сыктывкар, 235–237.

Anotācija

Lietuvas Zemkopības institūtā veikti lauka izmēģinājumi ar pļavas auzenes (*Festuca pratensis* Huds.) vietējām populācijām. Noskaidrots, ka attīstības ritma ziņā pļavas auzene kā suga ir ļoti viendabīga. Agrīnām un vēlīnām populācijām vārpošanas datums atšķīrās tikai par 2 dienām, bet vārpošanas datums un sēklu nogatavošanās laiks starp atsevišķiem augiem vienas populācijas robežās maksimāli atšķīrās tikai par 6 dienām. Pārsvarā dominēja agri vārpojoši augi – 62.25%; vēlīnie augi veidoja tikai 0.92%. Vēlīnu augu klātbūtne savvaļas populācijās pieļauj iespēju izveidot selekcijas materiālu no vēlīnām pļavas auzenes populācijām. Korelācija starp nogatavošanās laiku un pirmā pļāvuma zaļās masas ražu, kā arī starp nogatavošanās laiku un ģeneratīvo dzinumu daudzumu, no kuru skaita ir atkarīga pirmā pļāvuma raža, bija negatīva, kas arī apgrūtina vēlīnu un ražīgu pļavas auzenes šķirņu izveidošanu.