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Evaluation of the suitability of *Festuca rubra* L. and *F. nigrescens* Lam. ecotypes as a material for lawn grass breeding

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ABSTRACT

In the years 2004-2006, 37 *F. rubra* L. ecotypes and 35 *F. nigrescens* Lam. ecotypes were evaluated for their main lawn traits: the general aspect of the plant, slow re-growth, overwintering, winter greenness, leaf fineness and disease resistance. The lawn properties of the ecotypes were assessed with the use of the IHAR 9-grade scale of the visual quality classification system. The study individuals were compared with the model varieties: *F. rubra* 'Areta' and *F. nigrescens* 'Nimba'. The ecotypes originated from natural localities in the Lublin region. The experiment was conducted using the method of randomly chosen blocks in three repetitions. One repetition contained six plants of one ecotype grown at a distance of 75 × 30 cm. The aim of the study was to analyze the variability of lawn traits in the examined *F. rubra* and *F. nigrescens* ecotypes and to estimate the suitability of the selected material for the breeding of new lawn varieties. Analyses indicated that most of the ecotypes that grow in natural localities in the Lublin region display high-grade lawn traits. This confirms the great suitability of the wild plants for further breeding. Ecotypes of both species obtained high scores comparable with model varieties for their disease resistance, leaf fineness and winter greenness, and also for general aspect and slow re-growth.

Key words: general aspect, leaf fineness, overwintering, resistance of disease, slow re-growth, winter greenness

INTRODUCTION

Numerous factors, including the direction and criteria of cultivation, determine the effectiveness of breeding work. The initial material is the prime factor. The breeding and improvement of grass varieties requires a continuous supply of new taxa that display a set of favourable usability traits. Ecotypes that occur in the natural habitats and thus are best adapted to our soil and climatic conditions are the natural source of species genetic diversity. Therefore, they should serve as the main source of enriching the genetic base of grasses cultivated in our country (Góral and Pawluk 1978, Krzymuski 1991, Prończuk and Żurek 1994, Sawicki 1994, Żurek and Prończuk 1997, Martyniak 2004, Martyniak and Prończuk 2004).

In recent years, selection of the *F. rubra* and *F. nigrescens* ecotypes has received considerable attention. Such work is undoubtedly expensive and time-consuming; it is, however, indispensable for breeding success. As the natural environment undergoes progressive degradation, these grass species are of greater importance thanks to their biological traits, which facilitate survival in unfavourable – insufficiently fertile or wet – habitat conditions (Rutkowska and Brzywczy-Kunińska 1969, Prończuk 1994, Kozłowski 1997, Goliński and Kozłowski 1998, Sawicki 1999, Goliński and Xi 2000, Kozłowski et al. 2000, Prończuk and Prończuk 2000, Prończuk et al. 2003, Prończuk and Sawicki 2004).

The main aim of the study was to analyze the variability of morphological and biological traits in the

F. rubra and *F. nigrescens* ecotypes and to evaluate the suitability of the selected material for the breeding of new lawn varieties.

MATERIAL AND METHODS

The study material included 37 red fescue *Festuca rubra* L. ecotypes and 35 chewing fescue *Festuca nigrescens* Lam. ecotypes as well as lawn model varieties *F. rubra* 'Areta' and *F. nigrescens* 'Nimba'.

In 2000 and 2002, a selection of ecotypes was done in the natural habitats of the Lublin region. The main lawn traits were the criterion of the selection. Phenotypic variability was the basic prerequisite for selecting the ecotypes for further investigations. In spring 2003, the vegetative seedlings (five shoots in one seedling) of the selected fescue ecotypes were transferred from their natural localities and planted in the collection of the Maria Curie-Skłodowska University Botanical Garden. The experiment was conducted using the method of randomly chosen blocks in three repetitions. One repetition contained six plants of one ecotype grown at a distance of 75 × 30 cm**.** In the vegetative season 20 mowings were carried out at a height of about 5 cm. Mineral fertilisation was performed in three terms using N – 100, P_2O_5 – 70, K_2O – 90 kg ha^{-1} together. The investigations of the ecotypes in the collection were conducted in 2004-2006.

The lawn properties of the ecotypes were assessed with the use of the IHAR 9-grade scale of the visual quality classification system (Prończuk 1993, Prończuk et al. 1997), where 9 denotes the highest trait value (in the case of a disease no disease symptoms, i.e., tolerance). The following traits were assessed: the general aspect of the plant (in spring, summer and autumn), slow re-growth (in the first ten days of June, the third ten days of July and the third ten days of September), overwintering (in early spring), winter greenness (in January), leaf fineness and slenderness (in summer), and disease resistance - resistance (at the time of intense fungi growth) to pink snow mould *Microdochium nivale* (Fr) Samuels & Hallett, and especially to blister smut *Entyloma dactylidis* (Pass.) Ciff. as well as to red thread disease *Laetisaria fuciformis* (McAlp.) Burdsall.

The studied lawn properties of the ecotypes were compared with the model varieties on the basis of an analysis of variance at a 5% significance level. Correlation coefficients between the study ecotype properties were calculated.

The mean annual temperature in the study years was 8.8ºC, with the difference between the years of ± 0.4ºC (Fig. 1). The sum of atmospheric precipitation reached 480.2 mm, with a ± 84 mm difference between the years. The data were obtained from the weather station of the UMCS Department of Meteorology and Climatology situated in the centre of Lublin.

The collection was set up on brown soil formed from loess (33% of the fraction < 0.02 mm) with 2.72% humus content and neutral pH reaction in 1 mol KCl 7.1. The arable layer contained 304 mg of P_2O_5, 373 mg of K_2O and 168 mg of Mg per kilogram of soil. The ecotypes originated from areas displaying considerable differentiation of soil properties; placed in uniform soil conditions, they revealed the beauty of the phenotype.

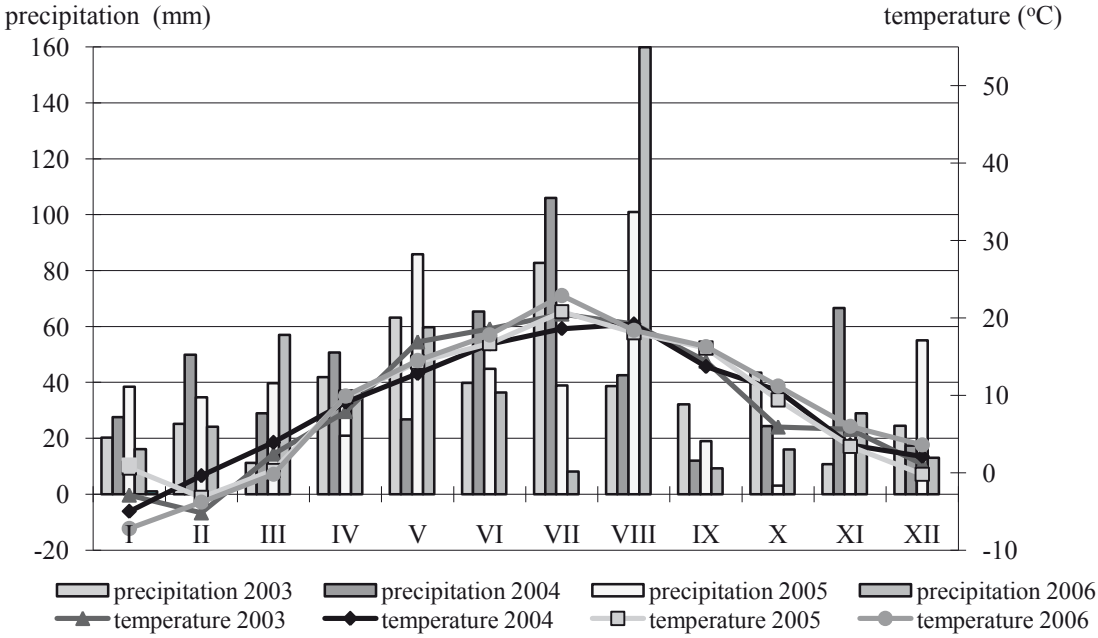

Figure 1. Monthly mean temperatures and sums of precipitation in 2003-2006 in Lublin

RESULTS AND DISCUSSION

Most of the selected *Festuca* ecotypes from natural habitats in the Lublin region were granted high grades in five out of the six study lawn properties: the general aspect, overwintering, winter greenness, leaf fineness, and resistance to disease. The grade level of the general aspect, slow re-growth, overwintering, winter greenness, leaf fineness and resistance to disease was highly comparable with the 'Areta' and 'Nimba' models (Tab. 1).

The general aspect of the plant is the main trait that determines the quality of the lawns. It ranged from 6.7 to 8.5 in the examined *Festuca* ecotypes, while in the models it reached over eight grades (Tab. 1). The research conducted by Prończuk and Żurek (1994), Żyłka et al. (2001), Martyniak and Prończuk (2003) demonstrated a high value of this trait in wild-type red and chewing fescues. The value of the general aspect changed in particular seasons and in subsequent years of cultivation. This was facilitated by the weather conditions during winter (Fig. 1) and the regeneration of plants after winter. Similar observations were made by other authors (Żyłka et al. 2001, Prończuk et al. 2003). The tendency in the changes in the studied trait was estimated using the linear trend method (Fig. 2). In our study, we observed interdependencies between the general aspect of the plant and re-growth, overwintering, winter greenness and disease resistance. In both fescue groups, the biggest influence on the general aspect of the plants was exerted by overwintering and winter greenness, and after that, the intensity of re-growth (Tab. 1). Similar dependencies were reported for some grass species by Prończuk et al. (1997), Żyłka et al. (2001), Jankowski et al. (2003), and Martyniak and Prończuk (2003).

Slow re-growth, which does not necessitate frequent mowing, is an advantage of lawn grasses (Żurek and Prończuk 1997, Jankowski et al. 2003, Martyniak and Prończuk 2003, Prończuk et al. 2003). Intensive re-growth of the *Festuca* ecotypes after mowing lowered their lawn value; both the individuals and the models were graded below five in the applied scale. (Tab. 1). Re-growth of the studied ecotypes was highly varied throughout the vegetative season. The trend line distinctly demonstrated a decline in this trait (Fig. 2).

Overwintering and winter greenness are important traits in breeding grasses for quality lawns. Several authors value these traits in both these species very highly – eight grades in the applied scale (Sawicki 1994, Żyłka et al. 2001, Prończuk and Sawicki 2004). Comparable results were obtained in the work on the selected *Festuca* ecotypes from the Lublin region (Tab. 1). This testifies to the good quality of the collection material, which was characterized by an attractive appearance during winter and spring. Aesthetic appearance out of vegetative seasons is important not only for decorative lawns, but also recreational and sports grounds, which are used from early spring until late autumn. According to Prończuk et al. (1997), the overwintering and winter greenness traits are important in selecting grass species for sport purposes. Overwintering and winter greenness of the analyzed ecotypes depended on the weather conditions during winter and early spring (Fig. 1). Also, a persistent snow cover affected the quality of these traits.

Table 1. Variability range for the six lawn traits (scale 1-9); last significant differences (LSD) between ecotypes were considered at the level of $p < 0.05$; correlation coefficients between general aspect and lawn traits

F. rubra	Ecotypes	'Areta'	LSD	Correlation coefficients
				General aspect
General aspect	6.71-8.51	8.49	1.49	-
Slow re-growth	3.89-4.89	4.78	n.s.	0.625**
Overwintering	6.88-9.00	8.61	1.58	0.787**
Winter greenness	6.94-8.94	8.61	0.86	0.784**
Leaf fineness	5.00-8.80	8.00	1.94	0.364**
Resistance of disease	8.50-9.00	8.88	0.31	0.239**
F. nigrescens		'Nimba'		General aspect
General aspect	6.73-8.45	8.26	1.50	-
Slow re-growth	4.22-5.06	5.00	0.82	0.861**
Overwintering	6.66-8.55	8.11	1.31	0.903**
Winter greenness	6.38-8.61	8.33	1.14	0.905**
Leaf fineness	5.66-9.00	7.80	1.86	0.191*
Resistance of disease	8.72-9.00	9.00	0.25	0.358*

*significance at the level = 0.05; **significance at the level = 0.01

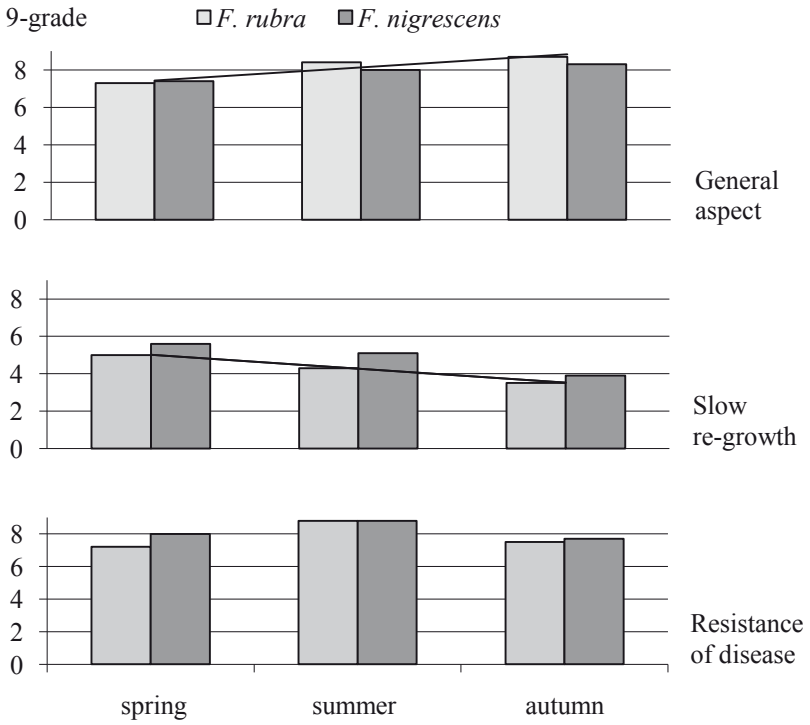

Figure 2. Characteristics of selected turf characters

Special, narrow-leaved varieties are bred for lawn mixtures (Jankowski et al. 2003). Specimens of the *F. nigrescens* growing in dense tufts were granted higher grades of leaf fineness (7.4 grades). Regardless of their density, the ecotypes of *F. rubra* had leaves assessed 6.8 grades in the three subsequent years of the experiment (Tab. 1).

In recent years, there has been increasing interest in decorative, recreational and sports lawns in Poland. There is also demand that they should be of good quality. Fungal diseases are responsible for lowering the aesthetic value of lawns (Prończuk 1996, 2002, Prończuk and Prończuk 1997, 2004, Prończuk et al. 2003). Therefore, substantial effort is being made to find phenotypes that are resistant or less sensitive to diseases. Both the studied specimens and the model varieties displayed good and very good resistance to the invasive pathogens. The infection ranged from grade seven to nine of the applied scale (Tab. 1). During the three years of investigations we observed increased occurrence of pink snow mould, blister smut and the red thread disease.

Snow mould was a predominant disease in the studied specimens. It was observed in each year of the study, and the first etiological symptoms appeared as early as in autumn 2003. Intense development of snow mould was observed under snow and at the border of melting snow in February and March 2005, and in wet weather in autumn 2004 (Fig. 2). Prończuk (1996, 2002), Prończuk and Prończuk (1997, 2004), and Prończuk et al. (2003) claim that the snow mould disease largely depends on weather conditions as well as on the condition of plants before wintertime and their cold resistance. Compared to the *F. nigrescens* ecotypes (8), the ecotypes of *F. rubra* (7.2) were the least resistant to snow mould. A similar dependency was found by Żyłka et al. (2001), Prończuk et al. (2003) and Prończuk and Prończuk (2004) in their study on varieties and families of fescue.

After intense precipitation in September and October 2004 and 2005 (Fig. 1), etiological symptoms of blister smut, i.e., greyish-brown and later black blisters filled with spores, were observed on the leaves. The infected leaves changed colour and later withered. The *F. rubra* ecotypes appeared less tolerant to this disease (7.5). Only an inconsiderable number of spots were observed on the *F. nigrescens* (7.7), (Fig. 2). According to Prończuk (2002) and Prończuk et al. (2003), the incidence of this disease is especially disastrous for grasses in recreational grounds and decorative lawns, because the fungus damages the lawns in spring and autumn, thus lowering their winter greenness. Prończuk (2000), and Prończuk and Prończuk (2004) report that the different sensitivity to blister smut in the *Festuca* species has not only theoretical but also practical significance. This trait is visible enough to be helpful in distinguishing *F. rubra* and *F. nigrescens*, which are similar in their morphological structure.

Wet and chilly weather in July (Fig. 1) promoted development of a disease that is commonly referred to

as red thread. The pathogen produced light pink spots on the tufts. The leaves of the infected plants lost their green colour and their re-growth was reduced. An assessment of the ecotypes was conducted in 2005, when the symptoms were most pronounced. According to our observations, both fescue species were sensitive to this disease (8.8), (Fig. 2). Prończuk (2002) claims that the development of this disease on these species largely depends on weather conditions (prolonged cold and wet weather) in summer and autumn and on the genetic susceptibility of the grasses.

Resistance of most of the studied ecotypes to pink snow mould, blister smut and the red thread disease was relatively high in the particular years of observation and significantly comparable to that of the model varieties. Infection with these diseases was pronounced in spring and autumn (Fig. 2). High resistance is desired in the breeding material and our results confirm the high suitability level of the assessed ecotypes.

CONCLUSIONS

1. Most of the *Festuca* ecotypes from natural habitats in the Lublin region received high grades of the following lawn traits: general aspect, overwintering, winter greenness, leaf fineness, and resistance of disease. This testifies to a broad selection of breeding plants.
2. The specimens of both *Festuca* species displayed an increasing value of the general aspect gradually from spring to autumn. The highest correlation coefficient values were obtained between the general aspect of the plant and overwintering, winter greenness and re-growth intensity. Therefore, good material for breeding should, first of all, be characterised by a high grade of overwintering and winter greenness.
3. Narrow-leaved *F. nigrescens* individuals may be more useful in decorative lawn mixtures, whereas *F. rubra* individuals, which have broader and stronger leaves, are suitable for sports lawns.
4. *F. rubra* and *F. nigrescens* ecotypes are characterized by the same general aspect as well as the remaining lawn values that were studied.

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OCENA PRZYDATNOŚCI EKOTYPÓW *FESTUCA RUBRA* L. I *F. NIGRESCENS* LAM. JAKO MATERIAŁU DO HODOWLI TRAW GAZONOWYCH

Streszczenie: W latach 2004-2006 przeprowadzono ocenę 37 ekotypów *F. rubra* L. i 35 ekotypów *F. nigrescens* Lam. pod względem najważniejszych cech trawnikowych: ogólnego aspektu rośliny, odrastania, przezimowania, zimozieloności, doskonałości liścia i zdrowotności. Cechy trawnikowe ekotypów oceniano według metodyki IHAR, stosując 9-stopniową skalę bonitacyjną. Badane osobniki porównywano do odmian wzorcowych: *F. rubra* ‘Areta’, *F. nigrescens* ‘Nimba’. Ekotypy pochodziły z naturalnych stanowisk Lubelszczyzny. Doświadczenie założono metodą losowanych bloków, w trzech powtórzeniach. W jednym powtórzeniu znajdowało się 6 roślin jednego ekotypu w rozstawie 75 × 30 cm. Celem pracy była analiza zmienności cech trawnikowych badanych ekotypów kostrzewy czerwonej i czarniawej oraz ocena przydatności wyselekcjonowanego materiału do hodowli nowych odmian trawnikowych. Na podstawie analizy wykazano, że większość ekotypów pochodzących z naturalnych siedlisk Lubelszczyzny posiadało pożądane cechy trawnikowe wysoko punktowane. Świadczy to o dużej przydatności dziko rosnących roślin do dalszych prac hodowlanych. Ekotypy obu gatunków *Festuca* ocenione zostały wysoko, podobnie jak odmiany wzorcowe, za zdrowotność, przezimowanie, doskonałość liści, zimozieloność, następnie za ogólny aspekt i odrastanie.

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