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Short Communication

THE ASSESSMENT OF *Agrostis capillaris* WILD POPULATIONS FOR USE IN TURF GRASS BREEDING

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Seed accessions were collected in Lithuania, Latvia and North West Ukraine. A total of 100 wild populations of Agrostis capillaris *were investigated and compared under the same conditions at the Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, during the period 2006–2012. The populations were assessed for the following traits: 1000 seed weight, seed weight per plant, plant height, panicle length, spikelet length, vegetative leaf length, leaf width, and beginning of inflorescence emergence. The coefficient of variation of individual traits (beginning of inflorescence emergence, spikelet length) was not high. The variation of other traits (1000 seed weight, plant height, panicle length, leaf width) was moderate. The variation of seed weight per plant was the highest, the variation coefficient of this trait ranged from 43.3% for the Lithuanian populations to 71.6 % for the Ukrainian populations. However, the averaged values of the tested traits did not significantly differ between the countries, except for the inflorescence emergence date. As a result, it is not expedient to discriminate the genetic resources of* Agrostis capillaris *according to geographic criterion. It can be inferred that because of the rather high variation of individual traits, wild populations of Agrostis capillaris can be successfully used in turf grass breeding.*

Key words: Agrostis capillaris*, variation of traits, genetic resources.*

The genus *Agrostis* L. includes approximately 150 species, one of which is *A. capillaris* L. It is a *Poaceae* species, which is rather widely distributed in the boreal zone and mountains. The species has relatively broad ecological amplitude and can be found in the communities of grasslands, sands and open forests.

The most significant practical application of *A. capillaris* is in turf establishment. The species is being widely used as a component in turf grass mixtures intended for various purposes and has received considerable researchers' attention. Scandinavian research evidence has shown individual varieties to perform differently in different cultivation environments (Aamlid *et al*., 2006). Recently, *A. capillaris* has been increasingly employed in the breeding of novel varieties. Only a few varieties developed in Germany and the Netherlands had been known by the year 1990; however, in 2009 the Organisation for Economic Cooperation and Development (OECD) list included as many as 34 *A. capillaris* varieties (Žurek and Ševčiková, 2010). One of the traits that explained breeders' interest in this bentgrass species is its tolerance of short cutting heights of 0.50–2.00 cm. This trait is especially desirable for golf course establishment. The currently increasing area under golf courses is raising the demand for *A. capillaris* varieties. When *A. capillaris* is mowed at a higher height of 2.5–3.0 cm this results in the formation of "felt", which deteriorates turf growth conditions (Klimas, 2006). As a result, the lawn of this species needs to be mowed at as short height as possible. The species performs well on fine-textured soils, characterised by weakly acidic or neutral reaction. It resumes growth rather late in spring, is resistant to frosts but susceptible to *Microdochium nivale*. *A. capillaris*, exhibits moderate shade and wear tolerance. There are no varieties of *A. capillaris* developed in Lithuania. The Lithuania-developed bentgrass variety Verknė is attributable not to *A. capillaris*, but to *Agrostis stolonifera* L. species. With a view to exploring the feasibility of *A. capillaris* breeding in Lithuania, we started collecting the seeds from wild *A. capillaris* populations growing in natural habitats in Lithuania and neighbouring countries. The seeds used in the current study were collected in Lithuania, Latvia and North West Ukraine. A total of more than 100 populations were collected which were our research material. The present study was designed to assess and compare the genetic potential of *A. capillaris* wild populations collected in different countries and to estimate the feasibility of using them in the breeding work, as well as to establish the correlations between the traits desirable for turf grass breeding.

Only the seeds of *A. capillaris* were collected for the populations' study, geographical coordinates of the sampling locations, as well as the distance to fixed objects were established, plant communities and associations were identified. Only those communities with *A. capillaris* populations, whose type was easy to determine were described in detail.

The studies on phytocenoses of the habitats were conducted over the period 2006–2012 in various geographical terrains of Lithua-

nia, Latvia and Ukraine. A navigation instrument was used to identify geographic coordinates and exact location of the habitat.

The nomenclature of syntaxons of meadows where *A. capillaris* occurred is provided according to the publications *Lietuvos augalija. Meadows* (Rašomavičius *et al.,* 1998) and *Latvijas Veģetācija*, 12 (Rūsiņa, 2007), of sands according to (Балявичене, 1991; Stankevičiūtė, 2000), and that of forests according to the classification described in *Lietuvos Dendroflora* (Balevičienė, 2003). Community classification was done to the association level. Smaller units were not established.

Experiments on dense sowing of *A. capillaris* species and their populations were set up in fields of the Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry on a flat terrain. The soil of the experimental site is *Endocalcari – Epihypogleyic Cambisol* with a pH_{KCl} of 6.5–7.0, 2.5–4.0% humus, 50–80 mg kg $^{-1}$ $P_2O_5$and 100–150mg kg $^{-1}$ K_2O.

To ensure polymorphism of the wild populations (cross-pollinating plants), a sample was composed of approximately 100 panicles (Guarino *et al*., 1995). Seed accessions were collected during expeditions in Lithuania, Latvia and the Ukraine. In March 2010, the seeds were sown in a greenhouse. In the second half of May the seedlings (30 per population) were transferred to experimental fields. The populations were tested for three successive years. The obtained data were processed using software developed by Tarakanovas and Raudonius (2003).

The plants transferred to the genetic collection were analysed for taxonomically significant morpho-anatomical and agro-biological traits. Phenophases were recorded during the study period. For the analysis of morpho-anatomical traits, in the second and third years of growth, herbaria were made for over-flowered plants. These were later used to determine the following morphological and anatomical traits: 1000 seed weight, seed number per plant, plant height, panicle length, spikelet length, vegetative leaf length, leaf width, and inflorescence emergence date. The morphological/anatomical analysis of the populations was conducted in 2011 and 2012.

Descriptions of the phytocenoses with *A. capillaris* were conducted using the Braun-Blanquet cover-abundance scale for vegetation analysis (Braun-Blanquet, 1964) (Table 1).

It was difficult to identify the communities of the populations collected in the Ukraine, and particularly those collected in the Carpathian region and forest-steppe zone. As a result, we could not provide information on the associations from which the accessions were collected in North West Ukraine. Table 2 presents a list of Lithuanian and Latvian associations of plant communities in which this species grows. Since no marked abundance differences between the associations in the two countries were revealed, they are presented in a joint table.

Table 1

BRAUN-BLANQUET COVER-ABUNDANCE SCALE

Braun-Blanquet scale	Range of cover (%)
5	75–100
4	50–75
3	25–50
2	5–25
1	< 5; numerous individuals

Obviously, *A. capillaris* can also grow in other communities: on unbroken soil, roadsides, quarries, etc. (Dierscke and Briemale, 2008).

In North West Ukraine, this species grows even in more variable communities. *A. capillaris* is rather abundant in Carpathian Alpine meadows and pastures and less frequent in the still surviving natural communities of the forest-steppe zone. The species is frequent on Polese unbroken soils and edges of pine forests. In Vovk's monograph *Zlaki Ukrainy* it is indicated that *A. capillaris* is more widely found in the northern part of the Ukraine, while in the southern part of the country occurs only in the Crimean mountains (Вовк, 1977). *A. capillaris* was a rather frequent species in North West Ukraine where we collected the accessions.

Although many researchers (Balevičienė *et al.,* 1998; Ruemmele, 2003) have reported low polymorphism of this species, the differences among the populations we studied were rather distinct. The tested traits exhibited moderate or even high variation coefficients (Table 3).

Table 2

COMMUNITIES IN LITHUANIA AND LATVIA IN WHICH *A. capillaris* GROWS

Association	Range of abundance and frequency
Cl. *Molinio-Arrhenatheretea elatioris* R. Tx. 1937	
Ass. *Molinietum caeruleae* W. Koch 1926	II[1]
Ass. *Festucetum pratensis* Soó 1938	I[1]
Ass. *Helictotricho pubescentis-Filipenduletum vulgaris* Balevičienė 1998	V[1]
Ass. *Anthoxantho-Agrostietum tenuis* Sillinger 1933	V[2-4]
Ass. *Festuco-Cynosuretum cristati* R. Tx. in Büker 1942	II[1-2]
Cl. *Festuco-Brometea erecti* Br.-Bl. et R.Tx. 1943	
Ass. *Pulsatillo-Phleetum phleoidis* Passarge 1959	II[1-2]
Ass. *Aveno-Medicagetum falcatae* Br.-Bl. et De Leeuw 1936	Sp
Ass. *Anthyllidi-Trifolietum montani* Matuszkiewicz 1984	III[1-2]
Ass. *Poetum compressae* Kizienė 1998	III[1-2]
Cl. *Trifolio-Geranieteta sanguinei* Th. Müller 1961	
Ass. *Geranio-Anemonetum sylvestris* Th. Müller 1961	I[1]
Ass. *Geranio-Trifolietum alpestris* Th. Müller 1961	I[1]
Ass. *Tripolio-Agrimonietum eupatoriae* Th. Müller 1961 (1962)	III[1-3]
Ass. *Agrimonio-Vicietum cassubicae* Passarge 1967	III[1-2]
Ass. *Stachys-Melampyretum nemorosi* Passarge 1967	II[1]
Cl. *Nardetea strictae* Rivas Goday et Borja Carbonell 1961	
Ass. *Polygalo-Nardetum strictae* Oberdorfer 1957	IV[1]
Ass. *Juncetum squarrosi* Nordhagen 1922	III[1]
Ass. *Calluno-Nardetum strictae* Hryncewicz 1959	IV[1]
Ass. *Carici-Nardetum strictae* Hryncewicz 1959	III[1-2]
Cl. *Koelerio-Corynepohoretea* Klika in Klika et Novak 1941	
Ass. *Diantho –Armerietum elongatae* Krausch ex Pötsch 1962	III[1-3]
Ass. *Festucstum polesicae* Regel 1928	I[1]
Ass. *Airo careophyllea-Festucetum ovinae* Sommer 1971	I[1-2]
Cl. *Vaccinio-Piceetea abies* Br.-Bl. 1939	
Ass. *Peucedano-Pinetum sylvestris* W. Matuszkiewicz (1962) 1973	I[1-2]

Table 3

COMPARISON OF *A. capillaris* POPULATIONS OF DIFFERENT ORIGIN

Traits	Latvian populations		Lithuanian populations		Ukrainian populations	
	$\bar{x} \pm S\bar{x}$	V, %	$\bar{x} \pm S\bar{x}$	V, %	$\bar{x} \pm S\bar{x}$	V, %
Plant height, cm	54.24 ± 1.5	8.76	50.89 ± 1.0	13.44	52.84 ± 2.34	14.66
Leaf length, cm	7.01 ± 0.36	16.6	7.52 ± 0.15	13.26	7.07 ± 0.25	11.65
Leaf width, mm	2.68 ± 0.1	12.01	2.61 ± 0.06	15.39	2.71 ± 0.13	16.09
Panicle length, cm	13.35 ± 0.65	15.44	11.96 ± 0.27	15.5	12.09 ± 0.57	15.59
1000 seed weight, g	0.06 ± 0.0	15.06	0.07 ± 0.00	18.01	0.06 ± 0.00	16.56
Seed yield, g	3.56 ± 0.53	47.06	3.25 ± 0.18	43.32	2.06 ± 0.52	71.36
Spikelet length, mm	1.85 ± .03	4.42	1.87 ± 0.01	5.43	1.93 ± 0.03	5.2
Inflorescence emergence date	03. 06		31. 05		29. 05	
Number of populations	20		45		35	

Comparison of the populations from different countries showed surprisingly small differences between the populations. Their variation coefficients were also comparable. However, the individual populations tested were rather variable. Some of them were relatively homogeneous with individual traits varying inappreciably, while others were heterogenic with individual plants being very different and with rather high variation of traits. The results obtained in 2011 practically did not differ from those obtained in 2012. There were marked differences only in plant height and inflorescence emergence date between the test years.

Spikelet length and width were found to be rather stable traits with a low degree of variability, while other traits varied more markedly. The Ukrainian populations tended to exhibit earlier inflorescence emergence, while the latest inflorescence emergence dates were recorded for the Latvia-collected populations. The reference variety 'Gudrun' was noted for the earliest inflorescence emergence, which in 2011 and 2012 occurred on May 24. The wild population (413) collected in Rezekne vicinity started inflorescence emergence at the earliest date, on May 26, and the population (349) collected in the Ukraine's pre- Carpathian region on May 27. Although a larger number of early populations were collected in the Ukraine, the populations exhibiting the earliest and the one showing the latest inflorescence emergence were collected in Latvia. The larger part of the tested populations started inflorescence emergence during the period from May 31 to June 4. Late populations were scarce. The latest inflorescence emergence date was recorded for population (216) collected in Lithuania in the lower Nemunas and population (385) collected in Talsi district in Latvia (June 10). Thus, the difference between the earliest and latest inflorescence emergence dates was 15 days. These populations provide good material for the development of early and late varieties. Although the averages for the populations of different countries did not differ significantly, certain trait differences stood out for the populations from smaller regions.

One of the major desirable traits for turf breeding is narrow leaf width. The largest number of narrow-leafed populations was collected in Lithuania — the leaf diameter for three populations was smaller than 2 mm. All of these populations grew in Southeast Lithuania.

The smallest seeds were produced by the population from Southeast Lithuania. Other populations collected here as well as one population from Latvia (Talsi district) produced small seeds.

Another essential trait is seed yield. The highest seed yield was produced by the populations from the Ukraine Polesje region; however, they had the widest leaves, which is undesirable for turf breeding.

The variation of plant height, leaf length, leaf width, panicle length, 1000 seed weight, seed yield, spikelet length, and inflorescence emergence date of populations collected in Lithuania, Latvia, and Ukraine was found to differ. The variation coefficient of inflorescence emergence date and spikelet length was low. The variation of 1000 seed weight, plant height, panicle length, leaf width was moderate. The largest variation was recorded for seed weight per plant. The variation coefficient of this trait of the populations from different countries varied from 43.3% for the Lithuanian populations to 71.6% for the Ukrainian populations.

It is very important for plant breeders to understand how individual traits correlate among themselves. We studied the relationships between only those traits that are relevant for *A. capillaris* breeding.

A relationship was established between the desirable traits leaf width and seed yield (Fig. 1).

Although this relationship occurred was opposite to that needed in breeding, several populations had rather narrow leaves and relatively high seed yield. Such populations are highly valuable.

Other fairly important traits are panicle length and plant height. A direct relationship was also established between these traits — taller plants had longer panicles and the plants with longer panicles produced higher seed yield (Fig. 2).

Other essential traits are seed size and seed yield. The correlation between these traits was also positive but not very strong. Plants that produced bigger seeds also produced higher seed yield (Fig. 3).

There were some populations (199 from Lithuania, 292 from Latvia) with small seeds but moderate seed yield. The plants of these populations are also valuable, as this trait combination would allow to sow a larger area with the same amount of seeds.

In conclusion, there were no significant differences between Lithuanian and Latvian habitats of *Agrostis capillaries*. The species grew in the same communities. The Ukrainian populations grew in more diverse communities. *A. capillaris* is a moderately polymorphic species. Seed yield had the highest variation among the populations tested. The least variable trait was spikelet

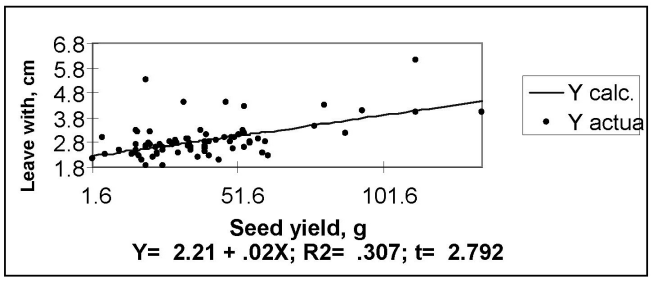

Fig. 1. Relationship between seed yield and leaf width.

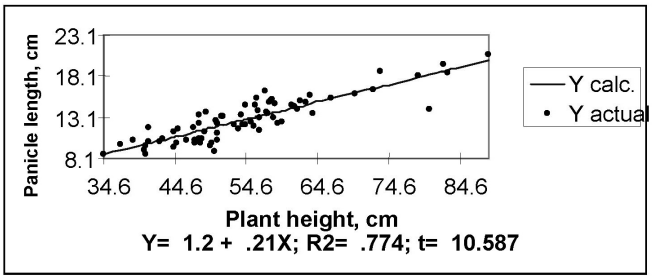

Fig. 2. Relationship between panicle length and plant height.

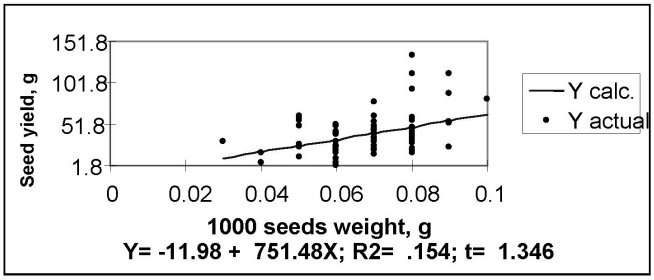

Fig. 3. Relationship between seed yield and 1000 seeds weight.

length. Moderate variation was recorded for other traits. The average values of the tested traits did not significantly differ between the countries, except for the inflorescence emergence date. The earliest inflorescence emergence was recorded for populations collected in the Ukraine. Lithuanian populations were medium in inflorescence emergence time (May 29), while the latest were for Latvian populations (June 3). The populations could not be grouped according to the countries, because only the differences between individual small regions were revealed. Relatively high correlation was established between plant height and leaf width, panicle length and seed yield. Morphological differences between individual populations were rather marked. The collected gene pool will be used for the development of novel varieties designed for lawns, recreational and other amenity uses.

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Agrostis capillaris SAVVAĻAS POPULĀCIJU NOVĒRTĒJUMS PIELIETOŠANAI MAURIŅA ZĀLIENU SELEKCIJĀ

Vērtējamais sēklas materiāls tika ievākts no Lietuvas, Latvijas un Ukrainas ziemeļrietumu daļas. Kopumā pētītas un salīdzinātas *Agrostis capillaris* 100 savvaļas populācijas vienādos apstākļos Lauksaimniecības institūtā, Lietuvas lauksaimniecības un mežsaimniecības pētniecības centrā laikā no 2006. gada līdz 2012. gadam. Populācijām tika vērtētas šādas pazīmes: 1000 graudu masa, sēklu masa no auga, augu augstums, skaras garums, vārpiņas garums, veģetatīvo lapu garums, lapas platums un ziedkopas parādīšanās sākums. Variācijas koeficients atsevišķām pazīmēm (ziedkopas parādīšanās sākums, vārpiņas garums) nebija augsts. Variācija citām pazīmēm (1000 graudu masa, auga augstums, skaras garums, lapas platums) bija vidēja. Variācija sēklu masai no auga bija vislielākā, variācijas koeficients šai īpašībai svārstījās no 43.3% Lietuvas populācijām līdz 71.6% Ukrainas populācijām. Tomēr pārbaudīto pazīmju vidējās vērtības būtiski neatšķīrās starp valstu paraugiem, izņemot ziedkopas parādīšanās datumu. Rezultātā nebūtu lietderīgi šķirot *Agrostis capillaris* ģenētiskos resursus pēc ģeogrāfiskās izcelsmes. Secinājumā *Agrostis capillaris* savvaļas populācijas var tikt veiksmīgi izmantotas mauriņa zālienu selekcijā, ņemot vērā atsevišķu pazīmju salīdzinoši lielo daudzveidību.