EVALUATION OF MEADOW FESCUE (*FESTUCA PRATENSIS* HUDS.) GERMPLASM FOR BREEDING PURPOSES

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Abstract

The aim of research is the evaluation of the germplasm through observations and measurements to choose valuable resources of initial breeding material. Were analyzed 16 accessions of Festuca pratensis Huds., in order to evaluate the genetic diversity within and among the breeding material sources concerning: heading date, abundance of vegetative and generative tillers, plant height, leaf diseases resistance, shape of plant and the correlation between traits. The traits investigated were analysed through the correlation matrix to estimate the correlations between the morpho - physiological characters The vegetative tillers are distinct significant positive correlation (0,81) with generative tillers and with plant height (0,77) and negative correlation with rust resistance (-0,06) and with heading date (- 0,22).The generative tillers are distinct significant positive correlation (0,80) with plant height also.

Keywords: *genotypes, meadow fescue, disease resistance, generative tillers, vegetative tillers,*

INTRODUCTION

The meadow fescue is one of the most important perennial forage grasses for meadows and grasslands. It is a medium-sized species, with rich foliage and fine leaves, which gives it a very high production and high nutritional value. It is resistant to frost and that is why it is very widespread in countries with harsh winters, particularly in the northern hemisphere. (VARGA et al, 1998). The cultivation zone is from the steppe area, up to the spruce forests. It grows best on clayey, heavy, nutrient-rich soils, but it can be found on many types of soil, except for dry or poor ones. (MOCANU et al.,2021). The forage mixtures which include meadow fescue are used both by grazing and mowing, for hay and semi-hay, contributing to ensuring quality forage. (MOGA I., SCHITEA M., 2000). Meadow fescue is compatible with the most important forage legumes (white and red clover, alfalfa, sainfoin) and perennial forage grasses, including timothy (*Phleum pratense*), tall fescue (*Festuca arundinacea*) and pernnial ryegrass (*Lolium perenne*). *Festuca pratensis* has a great ability to hybridize with perennial ryegrass (*Lolium perenne*) and Italian ryegrass (*Lolium multiflorum*). The prime aim in *Festulolium* cultivar

development has been to combine the agronomically desirable traits of *Lolium* (high forage yield and fast installation) and the stress resistance (frost and diseases resistance) of *Festuca* species. Suitable amphiploid and introgression breeding approaches have been developed (HUMPREYS M.W., Zwierzkowsky, Z., 2020). The genetic variability of all traits important for breeding proces represents a basic prerequisite for selection, which ensures the succes of the breeding process. (BABIC et al, 2018, 2023). BABIC et al. (2018) found the presence of significant variability within meadow fescue wild populations and cultivars for studied morphological, productive and quality traits. THOMAS et al (1996) found a considerable genetic diversity within *Festuca pratensis* for yield potential and for survival and high yield stability during both extreme drought and osmotic stress.

The main objectives of the breeding activity is to create cultivars with both high forage and seed yield, good forage quality, drought tolerance, good diseases resistance and persistency. In the present study a phenotypic characterization is given for 16 accessions of *Festuca pratensis* in order to evaluate the genetic diversity within and among the breeding material sources concerning: heading date, abundance of vegetative and generative tillers, plant height, leaf diseases resistance, shape of plant and the correlation between traits. Forage analysis using NIR measurement has been a major application of the technique largely due to the work of J.S. Shenk, M. Westerhaus, W. Barton, G. Marten, N. Martin, and a host of others who improved upon the technique and worked toward it's widespread use and acceptance among scientists as a valid analytical technique.

MATERIAL AND METHOD

The experiment was conducted in a field trial of the Research and Development Institute for Grasslands - Brașov, during the years 2023-2024. The plant material used in this experiment was represented by 16 accessions - breeding lines, with a total of 623 individual plants. The plants were obtained by sowing in March 2023, in the greenhouse, in rows in trays, followed by individual transplanting into small plastic pots. Maintenance works were applied: watering, weeding, phytosanitary treatments to prevent *Pythium* infections, repeated pruning to stimulate twinning. Particular attention is paid to ensuring equal treatment to each plant to avoid variability due to external factors, so that even from this early phase individual plants express their true genetic potential. When the seedlings were sufficiently well developed, with vigorous shoots and a well-developed root system, they were transplanted into the field, as individual plants, at equal distances of 50 cm, 10 plants per row and 36

rows/per block. The meteorological conditions in the years 2023-2024 (table 1) indicate a drier and warmer period compared to the multiannual average. Considering the recorded temperatures, in both years the values exceeded the multiannual average, with 0,6°C in 2023 and with 2.7°C in 2024. From the point of view of precipitation, the year 2023 recorded a total deficit of -182.8 mm and of -121,3 mm during the vegetation period, and in 2024 a total deficit of -22.6 mm and of 43,2 mm in the vegetation period compared to the multiannual average.

Table 1

Meteorological conditions from Brașov stationary 2023-2024

Years	**Annual average I - XII**	**Deviation**	**Vegetation period IV - IX**	**Deviation**
Temperature (°C)				
2023	10,1	+2,3	14,8	+0,6
2024	11,4	+3,6	17,6	+2,7
Average 59 years	7.8	0	14.2	0
Precipitation (mm)				
2023	570,4	-182,8	407,8	-121,3
2024	730,6	-22,6	485.9	- 43,2
Average 59 years	753.2	0	529.1	0

During the vegetation period of 2024 year, the following observations and determinations have been made heading date (inflorescence emergence), growth habit (before inflorescences emergence) (E – erect, S - semi-erect, P - prostate), number of vegetative tillers, scale 1 – 5, number of generative tillers, scale 1-5, plant heigh, the distance in cm from the plant base to the of panicle after anthesis, resistance to rust (% of healthy plants). The morphological and phenological characters were scored by visual inspection or measurements. The recorded data were statistically processed in the Statistica 7 software package.

RESULTS AND DISCUSSIONS

Regarding precocity, there were 8 days between the earliest: 6 May and the latest: 14 May, most of the genotypes having the heading date during 7-10 May. The growth habit was in most cases erect: 8 genotypes, followed by semi-erect: 5 genotypes and semi-erect - prostrate: 2 genotypes and prostrate: 1 genotype. The shape of the bush allows selection for different ways of use. Regarding the number of vegetative and generative tillers, genotypes with both vegetative tillers and abundant generative tillers were highlighted: Trans 2/2019, Trans 2/ 2020, Trans 2 /2021, Trans 2 /2022 and the

Moldova Botanical Garden, representing valuable biological materials for a new cycle of selection. Selection for improving seed yielding capacity correlated with a high forage yield is a major objective in breeding of grass species (BALAN M., 1999). The height of the plants did not vary widely, being on average between 68.3 cm for the Trans 2/2017 and 90.8 for Trans 2/2021. Disease resistance was noted in the case of rust attack, the resistant plants being the least numerous in the Rozon accession: 31%, the most resistant being Cosmopolitan: 87.5%. Rust, transmitted by *Puccinia* sp is the most damaging grass disease both in frequency and intensity of attack. (Table 2)

Table 2

Traits evaluation of *Festuca pratensis* accessions

Nr crt.	Accessions	Plants nr	Heading date	Growth habit	Vegetative tillers	Generative tillers	Plant height (cm)	Rust resistance (%)
1	Trans 2/2015	38	7.05	SE	4	4	77.5	73.7
2	Trans 2/2017	47	10.05	P	3	3	68.3	55.3
3	Trans 2/2018	39	6.05	SE	4	4	78.0	61.5
4	Trans 2/2019	49	9.05	E	5	5	79.8	67.3
5	Trans 2/2020	40	9.05	E	5	5	80.3	67.5
6	Trans 2/2021	49	9.05	E	5	5	90.8	65.3
7	Trans 2/2022	40	9.05	E	5	5	85.8	60.0
8	Trans 2/iz 2021	40	7.05	E	5	5	83.0	56.7
9	Barv 2020	40	10.05	SE	5	4	78.3	42.1
10	Barv 2021	40	8.05	E	4	5	75.5	40.0
11	Rozon	40	10.05	E	4	5	84.5	31.0
12	Grad Bot MD	50	7.05	E	5	5	86.5	57.6
13	Cosmopolitan	50	10.05	SE	4	4	78.3	87.5
14	Tampa 2016	40	10.05	SE-P	3	3	71.8	72.5
15	Tampa 2017	50	7.05	SE-P	4	4	76.0	53.0
16	Tampa 2018	20	14.05	SE	4	4	71.5	60.0

Disease resistance is an important factor in breeding objectives to ensure higher quality fodder production and an increased crop longevity. The results of observations and measurements were processed statistically, showing a small variation for height and heading date (cv smaller than 10%) a medium variance for vegetative and generative tillers (cv between 10 – 20%) and a high variance for resistance to rust (higher than 20%) (table 3).

Table 3

Descriptive statistic - The coefficient of variation for the studied parameters

Parameters	**Valid** N	**Mean**	**Confiden** -95.00%	**Confiden** 95.00%	**Mediu**	**Min**	**Max**	**Variance**	**Std. Dev.**	**Std. Error**	**CV %**
Vegetative tillers	16	4.3125	3.93728	4.68772	4	3	5	0.4958	0.7042	0.70415	16.3
Generative tillers	16	4.375	3.99198	4.75802	4.5	3	5	0.5167	0.7188	0.7188	16.4
Height (cm)	16	79.1188	75.92707	82.31043	78.3	68.3	90.8	35.876	5.9897	5.98968	7.6
Rust resist (%)	16	59.4375	52.04861	66.82639	66	31	87.5	192.28	13.866	13.8664	23.3
Heading date	16	69.75	68.89079	70.60921	70	67	73	2.6	1.6125	1.61245	2.3

The traits investigated were analysed through the correlation matrix to estimate the correlations between the morpho - physiological characters The vegetative tillers are distinct significant positive correlation (0,81) with generative tillers and with plant height (0,77) and negative correlation with rust resistance (-0,06) and with heading date (- 0,22). The generative tillers are distinct significant positive correlation (0,80) with plant height also (table 4).

Table 4

The correlation matrx

Parameters	Vegetative tillers	Generative tilleres	Height (cm)	Rust reistance (%)	Heading date
Vegetative tillers	1,00	0.81***	0.77***	-0.06	-0.22
Generative tillers		1,00	0.80***	-0.26	-0.26
Height (cm)			1,00	-0.07	-0.3
Rust resist (%)				1,00	-0.001
Heading date					1,00

Following the calculations made through the principal components analyses (PCA), three components was resulted, so the first 3 components bring a variance of 92.36 %. It is found that, accepting the expression of the initial causal space, respectively of the variables under study, through a single main component, only 54.58% of the initial variance is explained. Extending the number of main components to tree, the explanation of 92.36% of the total variance is ensured (Table 5).

Table 5

Eigenvalues of correlation matrix, and related statistics

Component	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	2.7292	54.5832	2.7292	54.5832
2	1.0263	20.5269	3.7555	75.1101
3	0.8628	17.2569	4.6184	92.3670
4	0.2248	4.4957	4.8431	96.8628
5	0.1569	3.1372	5.0000	100.0000

Principal component 1 (PC1) which represented 54.58 % of the total variation, includes the variables with the highest negative correlation coefficients: vegetative tilers (r=-0.90), generative tilers (r= -0.93), and plant height (r= -0,.91). Principal component 2 (PC2) which represented 20.52 % of the total variation includes the variable with positive correlation coefficients: rust resistance (r=0.20). Principal component 3 (PC3) which represented 17.25 % of the total variation include positive correlation coefficients: heading date (r=0.41) (tables 6).

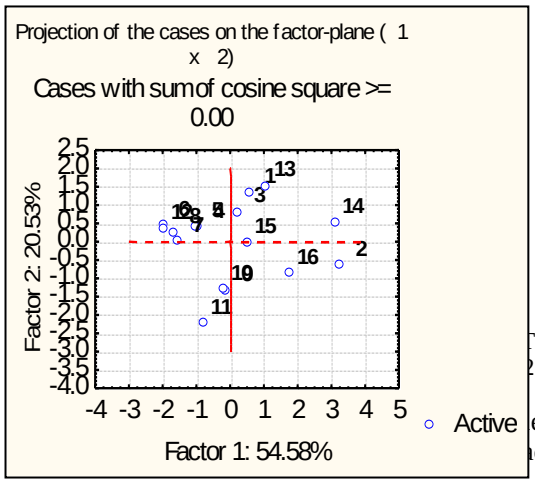
Table 6.

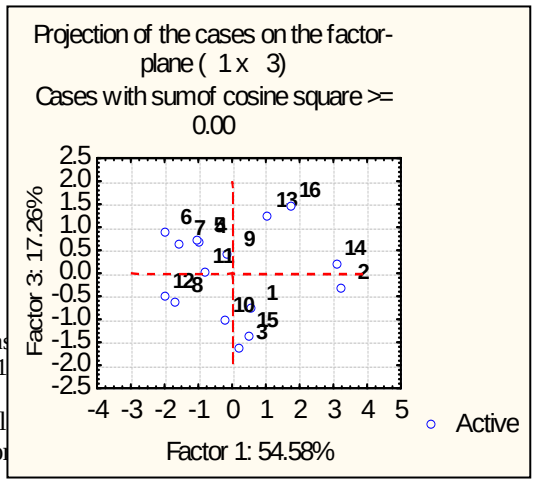
Factor-variable correlations, based on correlations

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Vegetative tillers	-0.9018	0.0694	0.2347	-0.3021	0.1890
Generative tillers	-0.9335	-0.1321	0.0890	-0.0444	-0.3183
Height (cm)	-0.9118	0.0953	0.1242	0.3607	0.1188
Rust resist (%)	**0.2085**	**0.9141**	0.3394	-0.0043	-0.0755
Heading date	**0.4121**	**-0.3993**	**0.8181**	0.0385	-0.0063

The genotypes Tâmpa 2016 and Trans 2/2017 represented in figure 1 a) with points 14 and 2, have a big contribution to the PC 1, namely vegetative tilers, generative tilers, and plant height. The abundance of vegetative tilers combining with the generative tillers give a high biological potential for break the existing negative correlations between seed and forage production. The Cosmopolitan (no.13) variety has positive contribution to PC 2 represented here by the rust resistance, and Rozon (no.11) have a negative contribution. In the breeding process the most resistant genotypes, with the frequency of over 80% resistant plants will be chosen. In the PC 3 (figure 1 b)), represented by heading date, the variety Tampa 2018 (no 16) has a big contribution. For identify the

most valuable genotypes that could be the basis for the creation of new qualitatively and quantitatively superior synthetic combinations and the highlighting and selection of the parental forms of *Festuca pratensis* Huds., it's good respond to the principals breeding objectives: increasing the forage and seed production, disease resistance and adaptability.





CONCLUSIONS

The positive correlation between vegetative tillers, considered the most important trait for forage production and the generative tillers, the basic criteria for the phenotypic selection in the purpose of obtaining varieties with high seed production, allow us to select genotypes with both features to be combined in the new genotypes. The high coefficient of variability concerning rust resistance offers the possibility to select resistant plants to this aggressive pathogen. The observations concerning the plant habit permit us to choose similar phenotypically genotypes to ensure the uniformity of a new genotype. The observations and determinations made on individual plants allow a convergent selection of valuable genotypes regarding the breeding objectives for the creation of new and superior varieties.

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