



Original Contribution

MORPHOLOGICAL CHARACTERISTICS AND CORRELATION DEPENDENCES AMONG QUANTITATIVE INDICATIONS IN BIRD'S FOOT TREFOIL CULTIVARS

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ABSTRACT

PURPOSE of the present study was to make a morphological analysis and calculate correlations among yield and quantitative indicators.

METHODS: It was based on the blocking method in 4 replications with a plot size of 5 m² with the following bird's foot trefoil cultivars: Targovishte 1, Alvena, Lotanova and Frilo, Polom, Bonnie, Bull.

RESULTS: It was found that the share of stems in grasslands was higher than the leaves, and the degree of variation in this indicator was low. Lotanova cultivar was the most productive with a registered dry matter yield of 1061.55 kg/da. The maximum share in grassland was realized by Alvena cultivar (73.8%), and the tallest stems were registered for Targovishte 1.

CONCLUSIONS: Parameters correlating with high values are dry matter yield and the percentage share of bird's-foot-trefoil in the grassland ($r = 0.6816$).

Key words: bird's foot trefoil, cultivars, morphological analysis, correlations

INTRODUCTION

Bird's foot trefoil is a legume meadow grass suitable for creating highly productive artificial grasslands (1). Many cultivars of bird's foot trefoil have been selected, widely used in practice due to their persistence (2), cold and drought resistance (3), the possibility of growing in different soil and climatic conditions (4), and high nutritional value (5, 6).

Natural conditions largely determine crop productivity. This requires a combination of stabilization parameters with soil and climatic conditions in the cultivation of cultivars in regions that are unstable in agrometeorological terms (7). Thus, cultivars cannot fully realize their genetic potential due to a low degree of adaptability (8).

The choice of a cultivar suitable for a specific area is essential for obtaining highly

productive and quality fodder (9). The degree of variation of the indicators (10) is decisive in the selection of genotypes suitable for inclusion in further selection work (11). The analysis of the significance of the differences in indicators of the different genotypes is the basis for the creation of a synthetic cultivar with good production qualities.

Determining the relationships between the morphological, eco-geographical, and chemical characteristics of bird's-foot-trefoil can give an idea of a better use of genetic plasmas. Some morphological properties, such as population growth form, flowering period, number of stems, length of the main stem, number of inflorescences per stem, number of flowers per inflorescence, number of pods per inflorescences, number of seeds per pod, and presence of hard seeds in the first year, dry matter yield and some chemical indicators are essential in conducting the selection work of bird's-foot-trefoil (12).

Statistical data processing allows for complete characterization of tested bird's foot trefoil samples, which proves the highest correlation

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(13) between the percentage of stems and dry matter yield, and in regrowths for seeds between the number of seeds per pod and seed yield (14, 15).

The aim of the present study is to make a morphological analysis and calculate correlations between yield and quantitative indicators in the cultivation of bird's-foot-trefoil cultivars.

MATERIAL AND METHODS

The experiment was conducted in the period 2016-2019 in the experimental field of RIMSA-Troyan by the block method in four replications, with a size of the harvest plot of 5 m². The following bird's foot trefoil cultivars were tested, compared to the Bulgarian cultivar Targovishte 1: Alvena, Lotanova and Frilo (Italy), Polom (Slovakia), Bonnie (France), Bull (Canada). Sowing was done by hand, spread at a sowing rate of 1,200 kg/da.

During the four years of the experimental period, two regrowths were harvested at hay maturity in the bud-formation period - the beginning of the flowering of bird's-foot-trefoil.

RESULTS AND DISCUSSION

Table 1. Morphological analysis (%) over the years

cultivars	2016		2017		2018		2019	
	leaves	stems	leaves	stems	leaves	stems	leaves	stems
Targovishte 1	54,5	45,5	52,4	47,6	55,6	44,4	46,8	53,2
Alvena	55,6	44,4	50,0	50,0	63,6	36,4	44,6	55,4
Lotanova	53,1	46,9	52,2	47,8	50,0	50,0	46,0	54,0
Frilo	53,1	46,9	50,0	50,0	54,5	45,5	50,9	49,1
Polom	57,1	42,9	52,4	47,6	50,0	50,0	42,2	57,8
Bonnie	55,6	44,4	52,4	47,6	50,0	50,0	41,2	58,8
Bull	53,1	46,9	52,2	47,8	58,3	41,7	41,7	58,3
x	54,59	45,41	51,66	48,34	54,57	45,43	44,77	55,23
sd	1,58	1,58	1,14	1,14	5,15	5,15	3,46	3,46
vc	2,90	3,48	2,20	2,35	9,44	11,34	7,74	6,27
min	53,10	42,90	50,00	47,60	50,00	36,40	41,20	49,10
max	57,10	46,90	52,40	50,00	63,60	50,00	50,90	58,80

In the year of sowing, 'Polom' (57.1%) had the largest and equal percentage share of leaves (**Table 1**). The share of leaves in the grassland for the standard cultivar was relatively high (55.6%) compared to all other cultivars. The percentage of leaves in the tested cultivars had the same or almost similar values. The lowest share of stems was registered in Polom

The following indicators were registered: morphological composition of grassland (%) - the weight percentage of 40 plants was measured, taken from each variant and each repetition during harvesting of the grassland, as the number of stems and leaves was determined by weight method and their percentage share was calculated on its basis. Correlation dependences between the average values for dry matter yield, percentage share of stems, leaves, the relative share of bird's-foot-trefoil in the grassland and heights in bird's-foot-trefoil cultivars (2016-2019) were calculated with the software products Analysis Toolpak for Microsoft Excel 2010 and Statgraphics Plus v.2.1. Data on the morphological composition of the grassland were presented by statistical processing, which includes: limit values (min and max), arithmetic mean (x), standard deviation (SD) and coefficient of variation (CV, %). The degree of variability is considered to be very low, low, medium, high, or very high at CV values, respectively: up to 7%; from 7.1 to 12%, from 12.1 to 20%, from 20.1 to 40% and over 40% (16).

(42.9%), and the highest in Lotanova, Frilo and Bull (46.9%). The degree of variation of the relative share of stems is insignificant, which is evident from the value of the coefficient of variation (VC=3.48). The difference between the highest value is 4.0 points.

A significantly higher presence of leaves than that of stems was observed in all tested cultivars in the second year of the experimental period. The difference between the maximum and minimum value is insignificant and the degree of variability is very low ($VC=2.20$). The largest and equal share of leaves is in Lotanova and Bull (52.2%), as well as in 'Polom' and 'Bonnie' (52.4%). The share of leaves in the grassland for Alvena and Frilo (50.0%) was slightly lower. The number of stems varies in insignificant limits, with a maximum value for Alvena (50.0%) and a minimum value for Polom and Bonnie (47.6%).

In the third experimental year, the highest percentage of leaves was in Alvena (63.6%). The relative share of leaves in the grassland of Lotanova, Polom and Bonnie (50.0%) is with equal and the lowest values. The average value of the share of leaves is 48.34%, with a

low degree of variability according to the value of the coefficient of variation ($VC=9.44$). The stems have the same or lower values than those of the leaves. The share of stems has similar values for Lotanova, Polom and Bonnie (50.0%), and the degree of variability is low ($VC=11.34\%$).

In 2019, quite similar values of the leaves in Polom, Bonnie and Bull make an impression. The highest percentage of leaves is in Frilo (50.9%) and Lotanova (46.0%). Slightly higher is the share of stems in the grassland of 'Bonnie' (58.8%). A minimal number of stems were reported for Frilo (49.1%). The differences in the values of the coefficients of variation of leaves and stems are low ($VC=7.74$ and 6.27%) according to Mamaev's scheme, but the degree of variability in terms of the percentage of leaves is very low, and the stems - low.

Table 2. Dry matter yield, (kg/da), relative share of bird's foot trefoil in the grassland (%), height of stems (cm), percentage share of stems and leaves on average for the period 2016 - 2019.

cultivars	Dry matter yield	Relative share of bird's-foot-trefoil	height of stems	stems	leaves
Targovishte 1	905,46	72.6	40,63	52,33	47,68
Alvena	1013,76-	73.8	40,05	53,45	46,55
Lotanova	1061,55+	70.3	37,97	50,33	49,68
Frilo	988,32-	71.2	36,82	52,13	47,88
Polom	1048,30-	72.1	39,71	50,43	49,58
Bonnie	978,22-	67.9	40,24	49,80	50,20
Bull	938,33-	65.9	38,27	51,33	48,68

The results in **Table 2** show the relatively lower values of dry matter yield compared to those of the standard on average for the study period. At an average yield of 905.46 kg/da of the standard cultivar Targovishte 1 of the other samples, a dry matter yield of 938.33 kg/da to 1061.55 kg/da was obtained. The lowest yield was registered for Bull and the highest for Lotanova. Only for Lotanova cultivar the positive difference in yield is statistically well proven, while in all tested cultivars the proof is negative. The different amounts of precipitation and air temperatures during the years of study, which are described in detail in another publication, are a prerequisite for the yield differentiation for individual genotypes. Relatively highest values of yield were reported in 2017 and 2018, when the amount of precipitation was relatively favourable, according to the biological requirements of

bird's foot trefoil. The data obtained confirm the findings of Golubinova and Marinov-Serafimov (1) that the year of study is a factor that has an impact on a larger share of the total variation. The observed differences in the realization of dry matter yield among the cultivars are explained by genetic differences, as the bird's-foot-trefoil cultivars are grown under the same agro-ecological conditions.

Bird's foot trefoil maintains a high percentage share in a large part of the tested cultivars on average for the study period. Its maximum presence is registered in the grassland of Alvena (73.8%), and Targovishte 1 (72.6%) and Polom (72.1%) have similar values. The lowest presence of bird's-foot-trefoil is registered for Bull (65.9%).

For the four-year study period, Frilo recorded the lowest average growth values (36.82 cm)

compared to the other cultivars included in the experiment. The standard cultivar has the highest value in terms of the biometric indicator of plant height (40.63 cm), which is determined by the favourable influence of soil and climatic conditions. No significant differences with regard to this indicator in the tested varieties were found. The variation is in a very narrow range of 3.81 points.

On average, during the study period, the number of stems prevailed in most of the varieties, and no significant difference between the individual genotypes was found. According to the results obtained for the percentage of leaves and stems, the studied varieties do not differ from each other. The number of leaves varies within very narrow limits (46.55 to 50.20%). The same trend was observed with regard to the percentage share of stems (from 49.80 to 53.45%).

Table 3. Correlation dependences between yield, percentage share of stems, leaves, the relative share of bird's foot trefoil in the grassland and heights on average for the period (2016-2019)

indicators	Yield (kg/da)	Bird's-foot-trefoil (%)	height (cm)	Stems (%)	Leaves (%)
Yield (kg/da)	1				
Bird's-foot-trefoil (%)	0,6816	1			
height (cm)	0,1058	0,15938	1		
Stems (%)		0,51869	-0,1188	1	
Leaves (%)	-0,1581	-0,51893	0,1159	-1,0000	1

The dependences among the main indicators forming the yield are presented in **Table 3**. According to the correlation coefficient, bird's-foot-trefoil percentage share in the grassland is essential in the formation of dry matter ($r=0.6816$). The indicators, such as the height of stems and the relative share of leaves correlate positively with dry matter yield ($r=0.1058$ and 0.1585). A weak positive correlation was also reported between the height of stems and the percentage of bird's foot trefoil in the grassland ($r=0.15938$).

When comparing the data with respect to the coefficients of linear correlation of the analyzed

traits, it was found that the percentage share of stems with the relative share of bird's-foot-trefoil in the grassland ($r = 0.51869$) has a greater impact.

Golubanova and Bozhanska (17, 18, 19) report that in the selection of bird's foot trefoil, the assessment of the individual elements influencing the yield is significant, under changing environmental conditions. The same author found a high positive correlation of plant height and number of stems in cultivars and populations of bird's-foot-trefoil with fresh plant biomass.

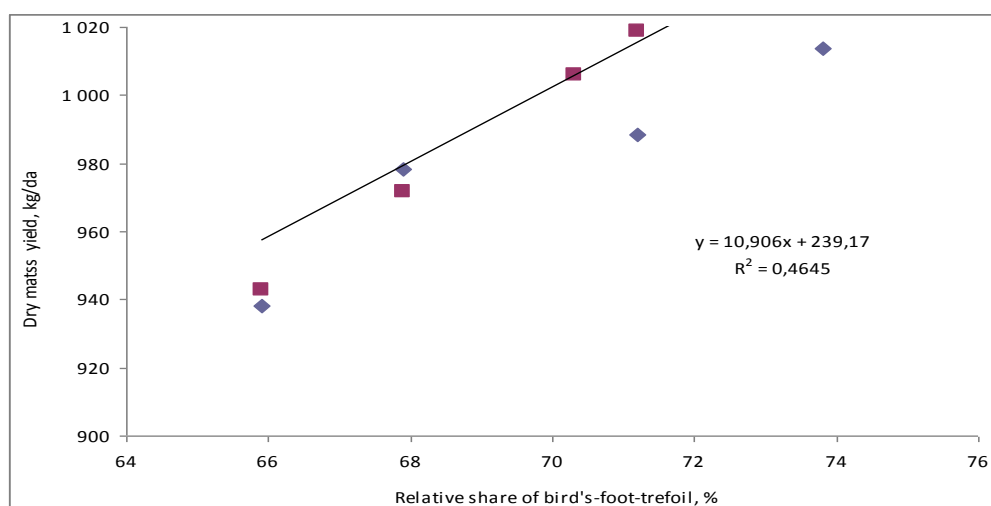


Figure 1. Regressional dependence between dry matter yield and relative share for different cultivars of bird's-foot-trefoil

The rational use of cultivars under specific soil and climatic conditions is closely related to their adaptability. The relative share of bird's-foot-trefoil in grassland is in good regressional dependence with yield $r=0.6816$, which confirms the good correlation between these indicators. The theoretical regression line and the equations of the regressional dependence between these indicators in the dry bird's-foot-trefoil biomass are shown in **Figure 1**, where $y=10.906x + 239.17$.

CONCLUSIONS

The morphological composition of grassland in the tested seven bird's-foot-trefoil cultivars under the conditions of the Central Balkan Mountains showed a higher share of stems compared to leaves and a low degree of variation in this indicator.

The dry matter yield of bird's-foot-trefoil varieties depended on the genotype and agroecological conditions. The most stable cultivar for the conditions of the Central Balkan Mountains on average for the period of study was 'Lotanova' cultivar, which stood out as the most productive with a dry matter yield of 1061.55 kg/da.

Alvena cultivar had the maximum presence in the grassland (73.8%), and Targovishte 1 had the highest stems.

According to the coefficients of linear correlation, in the formation of dry matter the percentage of bird's foot trefoil in grassland is essential ($r=0.6816$), therefore increasing the productivity of bird's-foot-trefoil cultivars can be achieved by increasing its relative share in grassland.

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