FUNCTIONAL RELATIONS BETWEEN MORPHOLOGICAL PARAMETERS AND YIELD VARIATION IN SOME FORMS OF BIRD’S-FOOT TREFOIL (Lotus corniculatus L.)

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Abstract. Bird’s-foot trefoil ensures the perennity of the meadows arranged vertically altitudinal and contributes to their sustainable use. For the establishment of sown meadows and oversowing of permanent grasslands, valuable Bird’s-foot trefoil varieties are needed, adapted to the climatic conditions of the area and with high production potential. The present paper is part of such an approach and aims to evaluate a collection of 16 forms of Bird’s-foot trefoil, representing a diverse range of agronomic types, in terms of morphological parameters regarding the production of seeds at the Bird’s-foot trefoil and the yield of fresh fodder and dry matter. The research was conducted between 2020-2022 in the natural framework provided by the experimental field of ARDS Lovrin. The results of this study indicate that based on the functional relationships between morphological parameters, the 16 forms of Bird’s-foot trefoil studied are divided into three large groups. For the production of the seeds, the forms of the Lv10, and Lv15 Bird’s-foot trefoil proved valuable, which showed a large number of generative shoots. In this regard, these forms of Bird’s-foot trefoil can be tested alongside the Lv13 and Lv8 genotypes. The highest yield was registered in the genotype Lv1 Bird’s-foot trefoil, which achieved a fresh fodder yield of 19 t. ha⁻¹ and a production of 4.39 t. ha⁻¹ dry matter, highly above the average of the experiment. Value for selection shows six more genotypes of Bird’s-foot trefoil that exceed the average of the experiment. This research is a basis for improving and selecting valuable, stable genotypes for future cultivation.

Keywords: Lotus corniculatus L., variability, fresh fodder yield, morphological composition.

INTRODUCTION

Bird’s-foot trefoil (Lotus corniculatus L.) is a species of the genus Lotus, being found in many meadows with different natural conditions (Ayres et al., 2007; Drobná, 2010; Uzun and Dönmez, 2016) due to its great ecological plasticity (Moisuc et al., 1998; Stoffella, 1998; Steiner and Santos, 2001).

In the hilly and mountain areas, on soils with low natural fertility and in extensive conditions of management, the presence of Bird’s-foot trefoil in the vegetation community of the permanent grasslands or of sown ones has of particular importance both in terms of increase of the fodder production, and especially in terms of the quality of the fodder (Dragomir et al., 2011; Rechițean et al., 2020, Kaplan et al., 2022).

Due to the fact that it has a high perenity, it resists well to grazing, it is considered to be a basic component for the establishment of long-term use grasslands (Dragomir, 2005; Bozhanska, 2018). Bird’s-foot trefoil can also be used in mixtures together with more aggressive species of legumes (clover and alfalfa), because the competition will be determined by the mode of growth and perenity (Cojocariu et al., 2008; Naydenova et al., 2013).

From the ecological point of view, Bird’s-foot trefoil improves the physical, chemical and microbiological features of the soil (Borozan et al., 2013) and contributes to the prevention of erosion due to its well-developed root system and the ability of symbiotic fixation of atmospheric nitrogen (Escaray et al., 2012).

Due to the agronomic and ecological importance of Bird’s-foot trefoil there are required in various approaches studies regarding the improvement and the obtaining of new varieties in various environmental conditions (Vuckovic et al., 2007; Churkova, 2020, Golubinova and Marinov-Serafimov, 2019). Thus, various varieties and local populations of Bird’s-foot trefoil, with different origins, have been studied in terms of agrobiological and production features (Vuckovic et al., 2007; Köteles and Pereş, 2013; Grabber et al., 2014; Ferguson, 2017, Golubinova, 2018) depending on the selection objective pursued.

In the present paper were analyzed the functional relations between the morphological parameters regarding the seed production of Bird’s-foot trefoil and the yield of fresh fodder and dry matter of a collection of Bird’s-foot trefoil (Lotus corniculatus L.) genotypes.

MATERIAL AND METHODS

The experiment was carried out during 2020-2022 in the research fields for the inbreeding of fodder plants from Lovrin Agricultural Research and Development Station, in the conditions of the low plain of Banat region, in Romania.
The experimental variants were represented by 16 genotypes of Bird's-foot trefoil, noted as Lv1…Lv16, in the selection process. The original biological material comes from a collection field of Bird's-foot trefoil of biotypes from the spontaneous flora of the Banat region permanent meadows.

The experiment was placed in the field according to the block method, the harvested area being 5 m². The sowing was carried out manually in the autumn of 2020, using a quantity of 10 kg/ha⁻². During the two experimental years, two harvests were taken, one of fresh fodder and one of seeds.

To determine the production of fresh fodder, the harvesting of the plants was carried out at the beginning of flowering stage (Meier et al., 2009; Meier, 2018). The yield of fresh fodder per hectare (t.ha⁻¹), respectively the average yield by years and by experimental period, was determined by weighing the fresh fodder harvested from one square meter. The yield of the dry matter(t.ha⁻¹) was determined in the laboratory by drying the average samples (200 g) in the oven at a temperature of 105 °C until the samples reached a constant weight. The average values were calculated by years and the average for the experimental period.

For the evaluation of the height of the plants were selected 10 clones from each replicate, being measured from the ground surface to the top of the highest stems. The number of generative shoots was also determined consecutively. In the laboratory, the mass of 1000 grains and the length of the seed were determined. The average values were calculated from the obtained data.

For the characterization of the area of interest from a climatic point of view, several climatic parameters (daily values) recorded on the basis of 14 sensors by ARDS Lovrin meteorological station were used, between 2020 and 2022 (Figure1).

Figure 1. Climatic factors (period 2020 - 2022) from ARDS Lovrin

Figure 1 shows that in the study area the warmest months are June, July, August, due to low rainfall. The interpretation of the obtained data was done with the help of the programs: Excel 2010, PAST 10 (free version).

RESULTS AND DISCUSSIONS

In the inbreeding work on fodder plants, the parameters that influence the fresh fodder yield for feed are also of interest (Radovic et al., 2003; Karabulut et al., 2006; Radu et al., 2010) but also the agrobiological features regarding the production of seeds (Varga et al., 1976; Savatti et al., 2004, Nedelea and Madoșa, 2004).

At the 16 genotypes of the analyzed Bird's-foot trefoil, at the seed harvesting, the number and height of the generative shoots, the length of the pod, the number of seeds in the pod, as well as the characteristics of the seed: the length of the seed and the mass of 1000 grains (Figure 2) were determined.
The analyzed genotypes of Bird's-foot trefoil showed a variable number of generative shoots per plant, which ranged from 4 to 43. The genotype Lv10 of Bird's-foot trefoil recorded the highest number of generative shoots per plant and the genotypes with only 4 generative shoots were Lv7 and Lv12. This feature of the Bird's-foot trefoil has a great variability, being related to the successive formation of the floriferous shoots, a fact highlighted by other studies (Stephenson, 1984, PET et al., 2008, Churkova, 2011, Dönmez and Uzun, 2016).

We propose that the genotypes with less than 10 generative shoots (Lv1, LV3, Lv4, Lv6, Lv7, Lv7, Lv6, Lv7, Lv6, Lv7, Lv7, L Lv11 and Lv12) follow them during the selection process for the creation of new grazing genotypes based on the fact that they have a large number of vegetative shoots instead.

The shoots are semi-erect at most of the analyzed genotypes of Bird's-foot trefoil. Their height is an important production feature. Thus, in most of the genotypes from the studied Bird's-foot trefoil from this research, it was between 35 – 45 cm. The maximum height was recorded at LV2 (Figure 2).

![Figure 2. Representation of the main quantitative features of the Bird's-foot trefoil - using star graphics](image)

*Legend: NL – No. of generative shoots/plant, PH - Height of the plant (cm), PL - The length of the pod (cm), SN – No. of seeds/pods]*

The production of seeds is difficult; on one hand, due to the irregular flowering of the Bird's-foot trefoil, and on the other hand due to the fact that the pod is dehiscent and easily opens at ripening (Mckersie et al.,1981; Sareen, 2004). Quality seed is reflected in future production (Duda and Imbrea, 2012)

The length of the pods was between 2.7 and 3 cm, but the number of seeds in the pod was different, ranging from 19 to 36 at Lv1 and Lv11 (Figure 2). The explanation would be that in some pods there are fewer seeds but larger and in other pods more small seeds. Some studies show that larger seeds have a higher germination rate (Moga and Schitea, 2000; Sareen, 2004; Peț et al., 2008; Toth et al., 2015).

Figure 3 shows that in most of the genotypes of Bird's-foot trefoil studied there is a variation of the features regarding the production of seeds, except for four genotypes in which a dependency relationship between these features was found (Lv1, Lv4, Lv11 and Lv14).

![Figure 3. Variation of seeds development using area evolution](image)

*Legend: PL - The length of the pod (cm), SN - No of seeds/pods, MMB – MMB (g), SL – Seed length (mm)]*
Figure 4 shows the way of grouping of the genotypes of Bird's-foot trefoil cultivated on the basis of similarity relations. Thus we can see that there are three main groups of neighbors:

I. where the following genotypes of Bird's-foot trefoil are included: Lv6, Lv12, Lv2, Lv16, Lv3, Lv7;

II. where the following genotypes of Bird's-foot trefoil are included: Lv10, Lv15, Lv13, Lv8, Lv5 and Lv1

III. where the following genotypes of Bird's-foot trefoil are included: Lv4, Lv11, Lv14 and Lv1

The average fresh fodder yield of the Bird's-foot trefoil analysed genotypes, harvested at flowering pheno-phase, ranged from 6.5 t.ha⁻¹ (Lv12) to 19.0 t.ha⁻¹ (Lv1), the average value of the experiment being 11.7 t.ha⁻¹. Figure 5 shows that in eight genotypes of Bird's-foot trefoil, the fresh fodder yield exceeds the average value of the experiment. Significantly positive are the yield differences among the forms: LV1, LV3, Lv4 and Lv15.
The average dry matter yield varied from one year to the next, with an average value of the experiment output of 2.97 t. ha⁻¹. The maximum value was recorded at Lv1 of 4.39 t.ha⁻¹, which exceeds the average value of the experiment by 1.59 t.ha⁻¹ (Figure 6).

![Figure 6](image)

**Figure 6.** Graphical representation of differences between dry matter yield values and average values of the experiment

[Legend: Prod2 – dry matter yield; Av2 – experiment average value; Dif – production difference]

Generalised linear model applied for differences in fresh fodder yield and differences in dry matter yield in the genotypes of *Lotus corniculatus* studied (Figure 7) is presented in the form of the equation:

\[ Y = 0.21532x + 6.9389E-18 \]

Where: \( y \) - differences in fresh fodder yield in the genotypes of the Bird's-foot trefoil (Lv1 – Lv16),

\( x \) - differences in dry matter yield in Bird's-foot trefoil genotypes (Lv1 – Lv16).

Yield differences can be attributed to the genotype but also based on the impact of climate and soil factors (Moga and Schitea, 2005; Copăcean et al., 2019; Churkova, 2020), which can be considered as a key indicator of the growth, normal development and productivity of the Bird's-foot trefoil.
CONCLUSIONS

The results of this study indicate that the analyzed genotypes of Bird's-foot trefoil represent a valuable genetic material for the inbreeding programs.

Clasterial analysis shows that based on the functional relationships between morphological parameters, the 16 genotypes of Bird's-foot trefoil are divided into three large groups. The first group includes the genotypes of Bird's-foot trefoil: Lv6, Lv12, LV2, Lv16, Lv3 and Lv7; the second group includes the genotypes of Bird's-foot trefoil: Lv10, Lv15, Lv13, Lv8, Lv5 and Lv1; and the third group Lv4, Lv11, Lv14 and Lv1.

Thus, for the production of seeds proved to be valuable the genotypes Lv10, LV 15, which showed a large number of generative shoots (43 and 40 respectively), the average length of the pod being 2.9 cm, 19 seeds in the pod and the mass of 1000 grains was 1.16 g. In this endeavour, these genotypes of Bird's-foot trefoil can be tested alongside LV 13 and LV8 forms.

For the yield of fresh fodder and dry matter, the genotypes of Bird's-foot trefoil with a lower number of generative shoots proved valuable. The highest yield has the genotype Lv1 of Bird's-foot trefoil, which achieved a fresh fodder yield of 19 t.ha⁻¹ and a yield of 4.39 t.ha⁻¹ of dry matter, highly above the average value of the experiment.

In the future, the inbreeding and selection works dedicated to the Bird's-foot trefoil will continue at ARDS Lovrin, by increasing the collection of biological material from natural meadows.

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REFERENCES

