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# QUALITATIVE CHARACTERISTIC OF FORAGE OF BIRD'S-FOOT-TREFOIL CULTIVARS (LOTUS CORNICULATUS L.), GROWN IN THE REGION OF TROYAN

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## ABSTRACT

The chemical composition of following bird's foot-trefoil cultivars was evaluated: 'Bright', 'Georgia 1' (USA), 'Nueltin' (USA), 'Witt', 'Pardee' (USA), 'Roseau' (USA), 'Steadfast', 'Trevig' (USA), harvested in the experimental field of RIMSA-Troyan during the period of 2010/2012. The indicators for crude protein, crude fat, crude fiber, nitrogen-free extractable substances (NFE), calcium and phosphorus were followed. The correlation dependences among them, the yield and morphological composition of grassland were calculated. After their statistical processing and comparative assessment was found the variability among cultivars according to undergrowths.

Very low variability (VC) was registered regarding the content of crude protein (6.51 and 8.44), crude fiber (3.38 and 5.58), nitrogen-free extractable substances (5.02 and 3.46), ash (5.06 and 2.69) and it was low for calcium (10.97 and 7.99) and phosphorus (5.52 and 12.53). Genotypes of 'Trevig' and 'Pardee' cultivars were outlined as the most perspective for use in the selection programmes and for introduction in production under specific soil and climate conditions. 'Trevig' cultivar especially distinguished itself as it combined high content of protein (179.0 and 210.9 g kg-1) and low content of crude fiber (268.7 and 277.3 g kg-1).

The strong positive correlation between content of crude protein and the relative share of leaves in the grassland (r=0,796); the content of crude fiber and height of plants (r=0,605); generative organs and content of calcium (r=0,597), which were found, showed that these features were interrelated.

## Key words

Bird's-foot-trefoil; cultivars; chemical composition; correlation dependences.

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## INTRODUCTION

Bird's foot trefoil is significantly important forage legume culture with a wide variety of cultivars [2; 10; 11]. The abrupt climate changes during recent years and the high ecological plasticity of bird's-foot-trefoil cultivars are a prerequisite for their wider use in our country as a source of forage for joint cultivation together with meadow grasses [5]. The quality of bird's-foot-trefoil hay resembles that of alfalfa, but to a great extent it depends on the phase of its gathering.

The place of cultivation has an influence over the hay quality. In case of warmer and dry weather, more proteins are accumulated and less cellulose. The forage quality, its digestibility, energy and protein value are determined by the chemical composition and digestibility of dry matter [4]. Fiber components of plant cell walls are main indicators for forage quality [3, 7].

The available data on chemical composition and nutritional value of bird's-foot-trefoil forage refer to cultivars, which are cultivated under specific soil and climate conditions [9]. An effective method to enrich the genepool of forage meadow grasses is the introduction of cultivars of foreign selection. A lot of cultivars have been created all over the world, which combine high biological, morphological and qualitative indicators in their genom [12]. But not all of them could adapt and manifest their characteristics in countries and regions, which differ in their soil and climate conditions from the places where they have been created. There is not enough literature for the cultivars, which are tested and introduced in our practice in the recent years.

The aim of present research was to study the changes in chemical composition content of bird's-foot-trefoil cultivars and their interdependence with the yield and morphological composition of grassland under the agro-ecological conditions in Troyan in order to introduce them in the practice and to use them for the purpose of selection.

## MATERIAL AND METHODS

The forage quality of the following bird's-foot-trefoil cultivars was studied: 'Bright', 'Georgia 1' (USA), 'Nueltin' (USA), 'Witt', 'Pardee' (USA), 'Roseau' (USA), 'Steadfast', 'Trevig' (USA), harvested in the experimental field of RIMSA-Troyan during the period of 2010/2012. The only one Bulgarian bird's-foot-trefoil cultivar - 'Targovishte 1'. was used for a standard. The soil was light grey, pseudopodsolic with a low content of humus (2.21%) and total nitrogen (0.123%). The reserve of total and digestible phosphorus (0.194% and 14.3 mg/100 g soil) was good, and the digestible potassium (10.2%) was low. The reaction of soil was from averagely acid to acid, as pH in KCl was 4.3. The sowing method, fertilization and treatment of soil were described in a previous publication [6].

The samples for the chemical analysis of forage were taken in bud-formation period - the beginning of flowering of each undergrowth during the years of the experimental period. Plant materials were left to dry under natural conditions. Immediately prior milling, the samples had been dried in laboratory drying-furnace at a temperature of 60 0C in order to facilitate the milling. The milling was done in a laboratory mill with a size of particles 1.0 mm. The following indicators were determined from the absolutely dry samples: crude protein, crude fiber, crude ash, nitrogen-free extractable substances, crude fat, calcium and phosphorus.

The crude protein values were reported on the base of nitrogen, which was obtained through conversion of N x 6.25 after the Kjeldahl method [1]. Crude fibres were determined after Weende method on the basis of solubility of cellulosic components in solutions of sulphuric acid and potassium hydroxide. Crude ash content was determined by burning in a muffle furnace at $t^0$ 550$^0$C, calcium content – after Stots (complexometric), phosphorus – after vanadium-molybdenium method of Gerike and Kurmis. Crude fats were extracted in Soxhlet extractor with ordinary ether. Nitrogen-free extractable substances were calculated on the basis of the obtained crude protein, crude fat, crude fiber, mineral substances.

The statistical data processing was carried by variation-statistical method [8], which included: average value (x), minimal (min) and maximal (max) values. The degree of variability was expressed by variation coefficient (CV%) according to the scheme of Mamaev: up to 7 % - very low; 7.1-12% - low; 12.1-20% - average; 20.1%-40% - high and over 40% - very high. The initial data were processed according to the method of dispersion analysis [13]. Correlation dependences between main indicators of the chemical composition and dry matter yield, the height of plants and proportion of stems, leaves and generative organs were calculated by correlation coefficient of Brave and Pearson (r) by Microsoft Excel.

## RESULTS AND DISCUSSION

The years during the experimental period do not differ significantly in relation to the average annual temperatures. The average annual temperature for 2012 was 16.6$^0$C, which was by 1.1 and 1.7$^0$C higher in comparison with temperatures in 2010 and 2011. Significantly larger differences were found in relation to amount and distribution of rainfalls in the vegetation period. The highest amount of rainfall (585.9 mm) was in 2010, when both in spring and summer the soil had high relative humidity. The second year of the experimental period could be characterized as normal (446.9 mm), and the third as dry, with drought in June, July and August (when the rainfall was 20.8; 0 and 39.1 l/m$^2$).

### Chemical composition of dry matter of bird's-foot-trefoil cultivars in the first experimental year

The changes in chemical composition content of studied bird's-foot-trefoil cultivars in the first year was shown in Table 1.

Crude protein content in the first mowing for all cultivars was lower than this in the second mowing. Genotypes of 'Trevig' cultivar showed the highest crude protein content in both mowings, respectively 177.1 and 205.0 g.kg-1. Crude protein for

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all cultivars was with relatively low average value (155.2 и 187.5 g.kg-1) and low degree of variability according to values of variation coefficient (7.5 и 7.3).

**Table 1. Chemical composition of cultivars and population of bird's-foot-trefoil for 2010 г. in relation to mowings , g.kg$^{-1}$ dry matter**

| Cultivars | Crude protein | | Crude fats | | Crude fibre | | NFE | | Ash | | Calcium | | Phosphorus | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II | I | II | I | II | I | II |
| Turgovishe | 145.0 | 191.2 | 34.9 | 24.8 | 253.4 | 244.6 | 392.9 | 356.4 | 90.6 | 89.0 | 21.1 | 15.5 | 4.57 | 4.06 |
| Bright | 142.2 | 196.9 | 30.6 | 27.3 | 223.0 | 237.7 | 437.5 | 356.6 | 75.5 | 86.1 | 16.3 | 15.5 | 4.57 | 4.33 |
| Georgia 1 | 153.7 | 178.8 | 40.2 | 27.7 | 242.3 | 210.0 | 381.2 | 388.1 | 85.2 | 99.2 | 17.5 | 17.7 | 4.44 | 3.73 |
| Nueltin | 157.5 | 172.4 | 45.4 | 26.1 | 209.5 | 192.6 | 388.6 | 424.4 | 84.9 | 91.5 | 17.4 | 16.5 | 4.73 | 4.96 |
| Witt | 148.1 | 166.6 | 39.1 | 27.3 | 228.5 | 189.8 | 402.6 | 431.1 | 79.9 | 90.7 | 18.9 | 15.5 | 4.36 | 4.87 |
| Pardee | 139.1 | 201.1 | 27.0 | 22.1 | 240.2 | 233.3 | 414.6 | 360.7 | 85.1 | 84.2 | 19.8 | 18.8 | 4.68 | 5.78 |
| Roseau | 148.8 | 197.1 | 44.1 | 30.4 | 225.4 | 263.5 | 409.0 | 321.4 | 78.2 | 96.8 | 16.8 | 16.5 | 4.04 | 5.52 |
| Steadfast | 158.0 | 178.8 | 45.9 | 26.5 | 227.6 | 277.8 | 383.1 | 324.2 | 84.3 | 99.0 | 15.1 | 12.1 | 4.75 | 5.43 |
| Trevig | 177.1 | 205.0 | 41.2 | 29.5 | 217.5 | 246.7 | 387.4 | 332.1 | 74.5 | 95.3 | 10.6 | 12.2 | 4.21 | 5.70 |
| X | 152.2 | 187.5 | 38.7 | 26.9 | 229.7 | 232.9 | 399.7 | 366.1 | 82.0 | 92.4 | 17.1 | 15.6 | 4.48 | 4.93 |
| Sd | 1,14 | 1,37 | 0,66 | 0,25 | 1,35 | 3,02 | 1,83 | 4,07 | 0,53 | 0,55 | 0,30 | 0,22 | 0,02 | 0,07 |
| Vc | 7,48 | 7,31 | 17,12 | 9,14 | 5,87 | 12,98 | 4,58 | 11,11 | 6,46 | 5,92 | 17,80 | 14,36 | 5,429 | 15,16 |
| Max | 177.1 | 205.0 | 45.9 | 30.4 | 253.4 | 277.8 | 437.5 | 431.1 | 90.6 | 99.2 | 21.1 | 18.8 | 4.75 | 5.78 |
| Min | 139.1 | 166.6 | 27.0 | 22.1 | 209.5 | 189.8 | 381.2 | 321.4 | 74.5 | 84.2 | 10.6 | 12.1 | 4.04 | 3.73 |

Crude fat in studied cultivars did not differ significantly according to mowings. A close degree of variation was found according to mowings (27.0-45.9 and 22.1-30.4 g.kg-1), and average degree of variability for the first (17.12) and low (9.14) for the second mowing according to variation coefficient. More considerable differences were observed in crude fibre, as their average values according to mowings were almost similar, respectively 229.7 and 232.9 g.kg-$^{1}$. The standard cultivar of 'Targovishte 1' had the highest crude fibre content (253.4 g.kg$^{-1}$) for the first mowing, and 'Steadfast' (277.8 g.kg$^{-1}$) for the second mowing. The variation according this indicator was twice as high in the second mowing, and the degree of variability was very low in the first mowing (5.87) and low for the second one (12.98). According to data from Buxton [4], the crude fibre content is directly dependent on temperature sum and rainfall amount under which the grassland is being formed. There was a tendency for an increase in crude fibre content with increase in water availability in the grassland. Therefore, crude fibre content in the first year, which had the least rainfall amount during vegetation period, was less than the other two years of the experimental period. The average values of the Nitrogen-free extractable substances had approximately similar average values according to mowing (399.7 and 366.1 g.kg$^{-1}$). Variability in relation to this indicator in the second mowing was significantly more essential (321.4-431.1 g.kg$^{-1}$) than that in the first mowing (381.2-437.5 g.kg$^{-1}$). That determines also the higher degree of variability in the second mowing according to variation coefficient (11.11). The highest content of nitrogen-free extracts for the first undergrowth was outlined for 'Bright' cultivar, and 'Witt' was the second cultivar. Ash content among different cultivars in both mowings varied at a narrow range for all tested indicators according to its average values (64.6 g.kg-$^{1}$ for the first mowing and 59.2 g.kg-1 for the second mowing). Variability of calcium for the first undergrowth was higher (10.6-21.1 g.kg-1) in comparison with the second one (12.1-18.8 g.kg$^{-1}$). Maximal values for calcium according to mowings were reported for 'Targovishte 1' cultivar (21.1 g.kg$^{-1}$) and Pardee (18.8 g.kg$^{-1}$). Phosphorus content for the different cultivars was almost the same (4.04-4.75 g.kg$^{-1}$ and 3.75-5.71 g.kg$^{-1}$), and there was a difference among phosphorus content in different mowings. A very low degree of variability was calculated according to the value of variation coefficient for the first mowing (5.459) and it was average for the second mowing (15.1) at average value for mowings, respectively 4.48 g.kg$^{-1}$ and 4.93 g.kg$^{-1}$. 'Steadfast' cultivar realized a maximal amount of phosphorus for the first undergrowth, and for the second one were 'Pardee' and 'Trevig' cultivars.

## *Chemical composition of dry matter of bird's-foot-trefoil cultivars in the second experimental year*

Grass biomass of bird's-foot-trefoil cultivars differed significantly according to the chemical composition in the second year from the experimental period (Table 2).

For the first undergrowth, the average content of crude protein in the cultivars was 156.9 g.kg$^{-1}$, which was almost the same with the previous year. With higher crude protein content were outlined 'Roseau' (176.8 и 180.5 g.kg$^{-1}$), 'Trevig' (175.3 and 201.2 g.kg$^{-1}$) cultivars. There were no substantial differences according to mowings, which was obvious both in the average values, respectively 156.9 and 170.9 g.kg$^{-1}$, and in the limits of variation 131.4-176.8 and 148.1-211.2 g.kg$^{-1}$. According to values of variation coefficient, degree of variability in view of this indicator was low (9.53 and 9.63). Crude fats took very little share from the dry matter content, which was obvious from their low average values according to

undergrowths (28.4 и 28.6 g.kg$^{-1}$). Their variation limits for the first undergrowth were from 15.0 to 35.3 g.kg$^{-1}$, and for the second undergrowth from 23.5 to 32.6 g.kg-1. Degree of variability in view of this indicator was high for the first undergrowth (27.04) and low for the second one (10.29). Biomass of bird's-foot-trefoil cultivar for both mowings had significant higher crude fibre content than in the first year. The highest content of crude fibres in the first mowing had biomass from 'Nueltin' cultivar (391.5 g.kg$^{-1}$), and the least from 'Steadfast' cultivar (303.7 g.kg$^{-1}$). Their average values in the second undergrowth (271.7 g.kg$^{-1}$) were significantly lower than their values in the first undergrowth (340.8 g.kg$^{-1}$). 'Steadfast' (303.7) and 'Pardee' cultivars (246.7 g.kg$^{-1}$) had low crude fibre content according to mowings.

**Table 2. Chemical composition of cultivars and population of bird's-foot-trefoil for 2011 in relation to mowings, g.kg$^{-1}$ dry matter yield**

| Cultivars | Crude protein | | Crude fats | | Crude fibre | | NEF | | Ash | | Calcium | | Phosphorus | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II | I | II | I | II | I | II |
| Turgovise | 126.2 | 148.1 | 27.9 | 23.5 | 346.7 | 290.5 | 343.1 | 364.8 | 61.4 | 89.7 | 12.4 | 16.5 | 3.72 | 3.85 |
| Bright | 154.2 | 172.9 | 34.5 | 26.0 | 350.1 | 276.7 | 349.5 | 365.8 | 55.2 | 95.5 | 17.7 | 17.6 | 3.69 | 3.67 |
| Georgia 1 | 169.1 | 152.5 | 16.8 | 28.2 | 352.4 | 259.6 | 392.6 | 372.4 | 64.2 | 91.3 | 15.3 | 27.7 | 4.00 | 2.28 |
| Nueltin | 146.5 | 178.5 | 35.3 | 29.9 | 391.5 | 294.5 | 268.7 | 350.0 | 67.8 | 80.8 | 13.6 | 17.7 | 3.66 | 1.45 |
| Witt | 152.9 | 157.1 | 15.0 | 32.6 | 338.6 | 284.9 | 354.3 | 359.6 | 59.8 | 78.1 | 13.3 | 17.7 | 3.59 | 2.60 |
| Pardee | 159.5 | 169.8 | 33.6 | 32.1 | 328.3 | 246.7 | 351.8 | 383.8 | 64.8 | 81.9 | 18.7 | 21.0 | 4.04 | 4.46 |
| Roseau | 176.8 | 180.5 | 34.9 | 29.9 | 331.8 | 256.5 | 349.5 | 392.3 | 62.2 | 84.9 | 14.5 | 15.5 | 4.63 | 2.95 |
| Steadfast | 131.4 | 177.4 | 27.6 | 28.3 | 303.7 | 279.7 | 385.5 | 382.3 | 70.9 | 76.5 | 13.5 | 17.7 | 4.42 | 3.09 |
| Trevig | 175.3 | 201.2 | 29.9 | 26.5 | 324.2 | 256.5 | 368.4 | 392.6 | 55.7 | 78.4 | 11.9 | 19.9 | 4.05 | 3.65 |
| X | 156.9 | 170.9 | 28.4 | 28.6 | 340.8 | 271.7 | 351.5 | 373.7 | 62.4 | 84.1 | 14.5 | 19.0 | 3.98 | 3.98 |
| Sd | 1,49 | 1,64 | 0,77 | 0,29 | 2,43 | 1,72 | 3,55 | 1,49 | 0,52 | 0,67 | 0,23 | 0,36 | 0,036 | 0,092 |
| Vc | 9,53 | 9,63 | 27,04 | 10,29 | 7,13 | 6,33 | 10,10 | 3,99 | 8,30 | 7,93 | 15,93 | 19,13 | 9,02 | 29,42 |
| Max | 176.8 | 201.2 | 35.3 | 32.6 | 391.5 | 294.5 | 392.6 | 392.6 | 70.9 | 95.5 | 18.7 | 27.7 | 4.63 | 4.46 |
| Min | 131.4 | 148.1 | 15.0 | 23.5 | 303.7 | 246.7 | 268.7 | 350.0 | 55.2 | 76.5 | 11.9 | 15.5 | 3.59 | 145 |

In the second year, bird's foot trefoil reached maximum development degree, it formed longer and more stems in number, which in the moment of gathering had higher crude fibre content. With the age increase of plants, and increase in their height parameters, the concentration of crude fibre increased, which explained the obtained higher values of this indicator. The increase in protein content and decrease in fibre content were due to the fact that in the second undergrowth were formed lower stems and the content of leaves in the total yield was increased. Nitrogen-free extractable substances changed less in the different undergrowth. The values of nitrogen-free extractable substances were insignificantly higher for the cultivars in the second mowing. Higher than the average value of NFE for the first mowing (351.5 g.kg-1) were 'Georgia 1(392.6 g.kg-1), 'Steadfast' (385.5 g.kg-1), 'Trevig' (368.4 g.kg-1) cultivars). For the first mowing, the degree of variability was low (10. 10), and for the second mowing very low (3.99). The crude protein and crude fibres have considerably more influence over animals. They are used as indicators for the quality of voluminous forages [9]. The ash content was influenced insignificantly both in view of mowings, and in view of cultivars. Variation limits in the first undergrowth were from 55.2 to 70.9 g.kg-$^{1}$ at average value of 62.4 g.kg-$^{1}$, and for the second undergrowth from 76.5 to 95.5 g.kg-1 and average value 79.3 g.kg-$^{1}$. The degree of variability in view of this indicator for both mowings was low according to values of variation coefficient (8.30 and 7.93). And because in voluminous forages, fats participate with a little percentage from the dry matter content, ash does not participate in determination of digestibility and the nutrient value, and the Nitrogen-free extractable substances are calculable indicator. These three components have less important role in evaluation of content and nutrient equivalent of forages. Cultivars in the second undergrowth formed greater amount of calcium in comparison with the first undergrowth. For the first undergrowth, it had higher amount for 'Pardee' (18.7 g.kg$^{-1}$) cultivar, and for the second undergrowth in 'Georgia 1' (27.7 g.kg$^{-1}$) cultivar. With the exception of 'Trevig' cultivar (first undergrowth) and 'Roseau' cultivar (second undergrowth), all other cultivars exceeded the standard in relation to calcium content in the dry matter of bird's-foot-trefoil forage. Calcium content in bird's foot trefoil increased from the beginning of vegetation to flowering stage, when was performed the harvesting of grasslands. Phosphorus content for all cultivars in the second year in both undergrowths was lower than that for the first year. 'Bright', 'Nueltin' and 'Witt' were characterized with close values close, but below the standard, and the rest were significantly above it. The average phosphorus content according to mowings was respectively 3.98 g.kg$^{-1}$ for the first undergrowth and 0,311 g.kg$^{-1}$ for the second. The variation of phosphorus content was more significant for the second undergrowth than the first one. That defines also the very high degree in variability for cultivars for the second undergrowth (29,428) and low variability for the first undergrowth (9.026). Since phosphorus decreased strongly with plants growing tall, and calcium changed slightly during vegetation, calcium phosphorus ratio changed.

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## *Chemical composition of dry matter of bird's-foot-trefoil cultivars in the third experimental year*

The composition of annual legume grasses changed strongly during vegetation with the increase of the age of plants. The content of crude protein in the third year (Table 3), during the experimental period according to undergrowths, did not differ significantly in comparison with the previous two years. 'Trevig' had the highest crude protein content for both undergrowths (184.5 and 232.5 g.kg-1). For the second undergrowth, with the exception of 'Pardee' cultivar, all the rest cultivars had crude protein content above the standard cultivar. Considerably higher was the variation of this indicator for the second (124.9-230.4 g.kg-$^{1}$) than the first undergrowth (146.5-186.5 g.kg-$^{1}$), which corresponded with the low degree of variability of the crude protein of the first undergrowth (7.64) and the high variability of the second one (20.79). The crude fat content for both undergrowths was increased two times in comparison with that for the previous year, as a significant variation in cultivars was not found. Variation limits in the first undergrowth were from 37.1 to 57.9 g.kg-$^{1}$, at average value of 49.2 g.kg-$^{1}$, and for the second undergrowth from 36.3 to 51.1 g.kg$^{-1}$ and average value 43.7 g.kg-1. Crude fibre varied from 263.2 to 320.8 g.kg$^{-1}$ for the first undergrowth, and from 280.3 to 363.7 g.kg$^{-1}$ for the second undergrowth. For both mowings the degree of variability was low (7.37 and 8.54) according to that indicators). Crude fibre content was higher for the second undergrowth than the first, which is evident from the average values of this indicator (328.8 и 287.0 g.kg-$^{1}$). 'Pardee' cultivar was outlined with the lowest crude fibre content during the year (263.2 и 280.3 g.kg$^{-1}$). Nitrogen-free extractive substances for both mowings for all cultivars had high values, as the values in mowings were close.

**Table 3. Chemical composition of cultivars and population of bird's-foot-trefoil for 2012 in relation to mowings, g.kg$^{-1}$ dry matter**

| Cultivars | Crude protein | | Crude fats | | Crude fibres | | NEF | | Ash | | Calcium | | Phosphorus | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II | I | II | I | II | I | II |
| Turgovise | 148.9 | 142.2 | 49.8 | 50.7 | 277.5 | 308.7 | 391.6 | 348.9 | 67.0 | 57.2 | 13.1 | 18.7 | 4.82 | 3.80 |
| Bright | 152.9 | 178.9 | 47.4 | 36.3 | 283.3 | 355.3 | 383.1 | 340.1 | 64.7 | 56.9 | 13.2 | 15.4 | 3.93 | 4.23 |
| Georgia 1 | 169.6 | 189.9 | 50.2 | 40.0 | 280.8 | 362.5 | 369.7 | 312.9 | 76.3 | 57.7 | 14.3 | 15.5 | 3.10 | 3.34 |
| Nueltin | 152.9 | 154.8 | 57.9 | 51.1 | 302.9 | 307.0 | 325.7 | 347.5 | 69.7 | 63.5 | 16.5 | 16.6 | 3.45 | 3.09 |
| Witt | 150.3 | 197.6 | 51.5 | 37.1 | 274.5 | 323.8 | 361.2 | 336.3 | 66.7 | 58.0 | 15.5 | 16.6 | 3.19 | 3.89 |
| Pardee | 157.4 | 124.9 | 52.3 | 37.6 | 263.2 | 280.3 | 387.0 | 397.1 | 67.8 | 65.2 | 23.1 | 15.5 | 2.35 | 2.91 |
| Roseau | 146.5 | 132.3 | 49.3 | 47.9 | 315.5 | 329.3 | 332.3 | 335.9 | 68.6 | 62.9 | 18.6 | 17.6 | 3.06 | 3.40 |
| Steadfast | 159.3 | 201.6 | 47.2 | 44.5 | 320.8 | 363.7 | 309.2 | 329.6 | 74.6 | 60.6 | 17.6 | 17.6 | 3.31 | 4.24 |
| Trevig | 184.5 | 232.5 | 37.1 | 47.9 | 264.4 | 328.6 | 372.9 | 339.6 | 78.5 | 63.5 | 19.8 | 19.8 | 4.06 | 4.15 |
| X | 158.0 | 172.5 | 49.2 | 43.7 | 287.0 | 328.8 | 359.2 | 343.1 | 70.4 | 60.6 | 16.9 | 17.0 | 3.47 | 3.67 |
| Sd | 1,21 | 3.59 | 0,55 | 0,60 | 2,12 | 2,81 | 2,97 | 2,29 | 0,48 | 0,32 | 0,33 | 0,15 | 0,07 | 0,05 |
| Vc | 7,64 | 20.79 | 11,26 | 13,76 | 7,37 | 8,54 | 8,26 | 6,66 | 6,85 | 5,34 | 19,59 | 9,00 | 20,46 | 13,71 |
| Max | 184.5 | 230.4 | 57.9 | 51.1 | 320.8 | 363.7 | 391.6 | 397.1 | 78.5 | 6.52 | 23.1 | 19.8 | 4.82 | 4.24 |
| Min | 146.5 | 124.9 | 37.1 | 36.3 | 263.2 | 280.3 | 309.2 | 312.9 | 64.7 | 56.9 | 13.1 | 15.4 | 2.35 | 2.91 |

The average values according to NFE for the first mowing was 370.1 g.kg$^{-1}$, and for the second mowing 361.0 g.kg-$^{1}$. Degree of variability was defined as very low according to variation coefficients (5.02 and 3.46), which was obvious also from the slight variation, which was due to the minimum and maximum values according to this indicator. There were no substantial differences in the ash content according to mowings for the different cultivars. Their values for different cultivars were close, and their average values according to mowings were respectively 70.4 and 60.6 g.kg-$^{1}$ with very low degree of variability (6,85 and 5,34). Calcium degree in dry matter for the different bird's-foot-trefoil cultivars varied from 13.1 to 23.1 g.kg-$^{1}$ (first mowing) and from 15.4 to 19.8 g.kg$^{-1}$ (second mowing). Because of the low share of that macroelement, the variation in obtained values was insignificant. Calcium content in dry matter of bird's-foot-trefoil cultivars was twice less than phosphorus. According to variation coefficients, the degree of variability of first undergrowths (19,59) was much higher in comparison with the second undergrowth (9.0). Data analysis for macroelements showed that there was average phosphorus content in the dry matter of tested bird's-foot-trefoil cultivars, respectively 3.47 and 3.67 g.kg-$^{1}$. It could be noticed in the presented results that variation of phosphorus content was higher than calcium Results showed that after a three-year study, the cultivars remained genetically stable in relation to the qualitative indicators. This was evident from the significantly low variation coefficients for greater share of the obtained results.

## *Chemical composition of dry matter of bird's-foot-trefoil cultivars averagely for the period*

The average data of the chemical composition for the studied cultivars are presented in Table 4.

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**Table 4. Chemical composition of cultivars and population of bird's-foot-trefoil averagely for the period 2010 – 2012**

| Cultivars | Crude protein | | Crude fats | | Crude fibres | | NEF | | Ash | | Calcium | | Phosphorus | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | I | II | I | II | I | II | I | II |
| Turgovishe 1 | 146.7 | 160.5 | 37.5 | 33.0 | 292.5 | 281.3 | 375.9 | 356.7 | 73.0 | 78.6 | 15.5 | 16.9 | 4.37 | 3.90 |
| Bright | 149.8 | 182.9 | 37.5 | 29.9 | 285.5 | 289.9 | 390.0 | 354.2 | 65.1 | 79.5 | 15.7 | 16.2 | 4.06 | 4.08 |
| Georgia 1 | 164.1 | 173.7 | 35.7 | 32.0 | 291.8 | 277.8 | 381.2 | 357.8 | 75.2 | 82.7 | 15.7 | 20.3 | 3.85 | 3.12 |
| Nueltin | 152.3 | 168.6 | 46.2 | 35.7 | 301.3 | 264.7 | 327.7 | 374.0 | 74.1 | 78.6 | 15.8 | 16.9 | 3.95 | 3.17 |
| Witt | 150.4 | 173.8 | 35.2 | 32.3 | 280.5 | 266.2 | 372.7 | 375.7 | 68.8 | 75.6 | 15.9 | 16.6 | 3.71 | 3.79 |
| Pardee | 152.0 | 166.6 | 37.6 | 30.6 | 277.2 | 253.4 | 384.5 | 380.5 | 72.6 | 77.1 | 20.5 | 18.4 | 3.69 | 4.38 |
| Roseau | 157.4 | 170.0 | 42.8 | 36.1 | 290.9 | 283.1 | 363.6 | 349.9 | 69.7 | 81.5 | 16.6 | 16.5 | 3.91 | 3.96 |
| Steadfast | 149.6 | 185.9 | 40.2 | 33.1 | 284.0 | 306.7 | 359.3 | 345.4 | 76.6 | 78.7 | 15.4 | 15.8 | 4.16 | 4.25 |
| Trevig | 179.0 | 210.9 | 36.1 | 34.6 | 268.7 | 277.3 | 376.2 | 354.8 | 69.6 | 79.1 | 14.1 | 17.3 | 4.11 | 4.50 |
| x | 155.7 | 177.0 | 38.8 | 33.0 | 285.8 | 277.8 | 370.1 | 361.0 | 71.6 | 79.1 | 16.2 | 17.2 | 3.98 | 0,390 |
| sd | 1,01 | 1,49 | 0,37 | 0,21 | 0,96 | 1,55 | 1,86 | 1,25 | 0,36 | 0,21 | 0,18 | 01.4 | 0,022 | 0,049 |
| vc | 6,51 | 8,44 | 9,44 | 6,46 | 3,38 | 5,58 | 5,02 | 3,46 | 5,06 | 2,69 | 10,9 | 79.9 | 5,52 | 12,53 |
| max | 179.0 | 210.9 | 46.2 | 36.1 | 301.3 | 306.7 | 390.0 | 380.5 | 76.6 | 82.7 | 20.5 | 20.3 | 4.37 | 4.50 |
| min | 146.7 | 160.5 | 35.2 | 29.9 | 268.7 | 253.4 | 327.7 | 345.4 | 65.1 | 75.6 | 14.1 | 15.8 | 3.69 | 3.12 |

It could be seen that as far as the crude protein content is concerned, 'Trevig', 'Steadfast' and 'Bright' significantly exceeded the standard. The progeny of these cultivars allow to include them in a new cycle of selection and to provide the opportunity for accumulation of valuable genes of a new population and to increase the share of recombinants in pollination for the second time. Regarding the crude fibre content, the best distinguished cultivars were 'Trevig' (268.7 $g.kg^{-1}$) for the first undergrowth and 'Pardee' for the second undergrowth (253.4 $g.kg^{-1}$). It could be seen from the results, that the changes concern primarily the content of crude protein and crude fibre. The other indicators, such as crude ash, crude fat and NFE changed more slightly. Crude fats and crude ash had insignificant degree of variation for the tested cultivars according to undergrowths and had a low relative share from the dry matter content. The very low degree of variability in relation to NFE indicator for both mowings (5.02 and 3.46) could be explained with the insignificant difference of minimum and maximum values.

The amount of macronutrients in dry matter for bird's-foot-trefoil cultivars found in this study was low and was within the limits of minimum and maximum levels, which were obtained under the soil and climate conditions of our country. In analyzing the results of the correlations of qualitative indicators with some morphological characteristics, such as plant height, percentage share of stems, leaves and generative organs, was found that there was a proven correlation among studied indicators (Table 5). Data confirmed the proven and average positive correlation of yield only with ash content (r=0,589). As the age of grassland and height of stems are one of the main indicators that influence crude fibre content, the correlation among them (r=0,605) that was found and proven, justified obtained data. The relative share of stems showed relatively low and unproven, but positive correlation of stems with the content of crude fibre (r=0,039) and ash (r=0,033). Of the studied indicators, only crude protein content had a high positive correlation in relation with the percentage share of leaves (r=0,796). The relationship between leaves and crude fibre (r=0,238) and ash (r=0,186) and calcium (r=0,132) was slight and unproven. The relation between leaves and crude fats, NFE and phosphorus was negative and unproven, which gives us reason to think that signs were not closely related. Generative organs were in a weak positive, but unproven correlation with NFE (r=0,342), and in strong with calcium content (r=0,597). The lack of significant, diverse and proven values in most cases for correlation coefficients of generative organs and content of crude protein, crude fat, crude fibre and phosphorus (r=-0,851; - 0,003; -0,292 and -0,395) showed that dependence was slight and signs were independent. This shows that the indications were genetically dependent and the selection in relation to quantitative indicators would not have a negative influence over productivity.

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**Table 5. Correlations among main indicators of the chemical composition, yield and main indicators of the morphological composition of grassland**

| Indicators | Yield | Height | Stems | Leaves | Generative organs |
|---|---|---|---|---|---|
| Crude protein | -0,321 | -0,047 | -0,546 | 0,796$^{++}$ | -0,851 |
| Crude fats | -0,006 | -0,047 | -0,070 | -0,003 | -0,003 |
| Crude fibres | -0,473 | 0,605$^{++}$ | 0,039 | 0,238 | -0,292 |
| NEF | -0,344 | -0,195 | -0,100 | -0,073 | 0,342 |
| Ash | -0,047 | -0,071 | 0,033 | 0,186 | 0,004 |
| Ca | 0,589$^{+}$ | -0,454 | -0,298 | 0,132 | 0,597$^{+}$ |
| P | -0,818 | 0,055 | 0,099 | -0,054 | -0,395 |

## CONCLUSIONS

Database was obtained for the chemical composition of different cultivars of bird's-foot-trefoil for a three-year period of study and after a statistical processing and comparative assessment was found the variation among cultivars according to undergrowths.

There was a very low variability for the content of crude protein (VC-6.51 and 8.44), crude fibre (VC-3.38 and 5.58), NFE (VC-5.02 and 3.46), ash (5.06 and 2.69) and it was low for calcium (10.97 and 7.99) and phosphorus (VC-5.52 and 12.53). The presence of insignificant differences among cultivars, as well as the low values of variation coefficients in majority of studied indicators was a proof for their balancing.

As a result from the chemical analysis of dry matter according to 7 main indicators, as the most perspective for use in the selection programmes and for introduction in the production, under the specific soil and climate conditions in Troyan, were distinguished genotypes of 'Trevig' and 'Pardee' cultivar.

The inclusion of the introduced cultivars, such as 'Trevig' and 'Pardee', in the selection programmes, increased the diversity in the genetic base, which makes effective selection of new genotypes of bird's-foot-trefoil according to qualitative indicators of forage.

The strong positive correlation between the content of crude protein and the proportion of leaves in the grassland (r=0,796); the content of crude fibre and the height of plants (r=0,605); generative organs and content of calcium (r=0,597) show that these features are interrelated.

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