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CORRELATIONS AND DEGREE OF VARIATION BETWEEN YIELD AND SOME INDICATORS OF GROWTH AND CHEMICAL COMPOSITION OF THE GRASS FROM THE BIRDSFOOT TREFOIL AND ITS MIXTURES WITH MEADOW GRASS SPECIES

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Abstract. From 2002 to 2005, the behaviour of local population of birdsfoot trefoil in binary mixtures with meadow grass species was conducted in the experimental field of RIMSA–Troyan. The variants of the experiment include testing of birdsfoot trefoil–variety *Turgovishte 1* (reference–St), cultivated its own and *local population* of birdsfoot trefoil in binary mixtures with tall fescue (*Albena*); perennial ryegrass (*Pleven population*); bromegrass (*Nika*); smooth–stalked meadow grass (*Troyan population*); orchard grass (*Dabrava*); red fescue (*Troyan population*); wheatgrass (*Ruff*).

The height of plants shall be amended under the influence of weather conditions, the rate of growth and development of grasses interrelation and competitiveness of the components in grass composition indicative of received Variation coefficients. The production of birdsfoot trefoil and grass types varied with regard to treatments and years. The variation coefficients indicating yields stabilityshowed that it was best expressed in the mixture of birdsfoot trefoil and tall fescue (CV=45.42%) andorchagrdgrass (CV=48.65%). The values of crude protein in all variants were negative correlation coefficient. The correlation coefficient of the compound with crude fiber content was very positive and strong correlation.

***Key words*:** birdsfoot trefoil, mixtures, productivity, chemical composition, correlation analysis, height

Introduction

The mixtures of birdsfoot trefoil with meadow grass species play an important role in obtaining high quality forage in mountainous regions [GORANOVA, 2007; VASSILEVA, 2011; VASILEV, 2011; LAZAREVIC *et al*., 2004; STOSIC *et al*., 2003]. Birdsfoot trefoil as legume component has the ability to fix nitrogen, which is used to stimulate the growth of cereal crops in the mixed grasses [CARLSSON *et al*., 2003; LINGORSKI V, 200].

The high protein content determined and better quality of grass biomass [BYRON *et al*., 2000; MITEV *et al*., 2008.]. Correlation coefficients determining the dependence of the yields of the main indicators for growth and forage quality of the show which grain components are suitable for obtaining longer and better quality products [SHABAN, 2006].

The studies between yield and some indicators of growth and chemical composition of the grass from the birdsfoot trefoil and its blends with wheat grass meadow on the conditions of light gray pseudopodzolic soils are not made.

The objective of this study was to determine the correlations and degree of variation between yield and some indicators of growth and chemical composition of the grass from the birdsfoot trefoil and its mixtures with meadow grass species.

Material and methods

The trial was held during 4 years period (2002–2005) in the experimental field of RIMSA, Troyan, using the block method in 4 replications with 5–m^2 size of harvest plots.

The variants of the experiment include testing of birdsfoot trefoil–variety *Turgovishte 1* (reference–St), cultivated its own and *local population* of birdsfoot trefoil in binary mixtures with tall fescue (*Albena*); perennial ryegrass (*Pleven population*); bromegrass (*Nika*); smooth–stalked meadow grass (Troyan population); orchard grass (*Dabrava*); red fescue (*Troyan population*); wheatgrass (*Ruff).*

The trial was set on light grey pseudpodzolic slightly reserved with N and P mean with K, with $pH_{(KCl)}$ 4.4. Technology for establishment of sown sward was applied in general in the Institute.

Together with the main soil cultivation, the fertilization with P_{80} and K_{80} ($kg.ha^{-1}$) was applied annually in the year of sowing and during the following in the autumn, after finishing the vegetation.

We applied N_{60} $kg.ha^{-1}$ while sowing in the first year and early in the spring in the

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following years. The study included average data of the different characteristics by years.

The average values (x), minimum (min) and maximum (max) limits of the height of the birdsfoot trefoil and cereal components; productivity and chemical composition were calculated [LIDANSKI, 1988].

The yield of dry mass was determined in kg.ha^{-1}.

The chemical composition of absolutely dry mass was determined by analyzing the grass taken immediately before each cut. Studied are the contents of content of crude protein (by the Kjeldal method), crude fiber (by the Heteron and Jensen), Crude ash (muffle incineration at t 550°C), calcium (complexometrically by Stotz) and phosphorus (colorimetrically by the Gerike and Curmis). The plants height (cm) was measured at the time of harvesting of the grass by cut. The degree of variation (CV) of parameters was determined though variation coefficient according to the scheme of Mamaev [LIDANSKI, 1988]: up to 7%–very low, 7.1 to 12% low, 12.1 to 20% moderate; 20,1–40% high: over 40%–very high.

Correlations (r) of Brave and Person were calculated to prove the relations between the different characteristics and their influence on productivity as well as between them. The data was processed by Microsoft Excel.

Results and discussion

Over the years, experienced a period of growth and development *(Table 1)* of grasses is the result of the distribution of precipitation and temperature values during the vegetation period.

Table 1

Arithmetic average (x), minimum and maximum values and variation coefficient (CV) of the plant height

Variants	birdsfoot trefoil				Grass components			
	min	max	x	vc	min	max	x	VC
birdsfoot trefoil (St)	20.2	56.3	36.8	29.8				
birdsfoot trefoil +tall fescue	19.7	48.7	35.5	17.3	25.6	98.5	56.8	48.7
birdsfoot trefoil+perenial ryegrass	23.5	49.3	36.5	24.4	26.3	92.8	54.6	42.4
birdsfoot trefoil +timothy	19.7	44.5	34.6	17.2	19.6	99.5	57.0	45.5
birdsfoot trefoil +bromegrass	19.0	47.2	35.7	17.5	23.5	103.9	54.2	55.4
birdsfoot trefoil +smooth–stalked meadow grass	21.1	48.2	36.7	27.5	29.2	103.6	58.9	49.1
birdsfoot trefoil +orchagrdgrass	22.1	45.4	36.5	15.3	27.1	113.3	66.2	49.2
birdsfoot trefoil +redfescue	19.7	43.6	34.8	13.6	24.2	95.2	51.9	54.2
birdsfoot trefoil +wheatgrass	23.4	48.8	36.3	23.4	22.1	76.7	44.3	49.2

More significant differences in height of plants for grass mixtures were established in the corn component. The values of the height of orchard grass in the mixture of birdsfoot trefoil an orchard grass is characterized by extreme variability.

The variation is widely–from 27.1 to 66.2 cm in variation coefficient 49.2%.

The average height of the birdsfoot trefoil with the same mixture was 36.46 cm, with an average degree of variability in variation coefficient CV =15.35%.

Relatively uniform height values were perennial ryegrass (54.59cm) and brome–grass (54.21cm) at a very high degree of variability, CV=42.44 respectively and 55.37%. The mean heights of plants of the birdsfoot trefoil in these mixtures were 36.49 and 35.66cm in relatively equal amounts of variational ratio–17.31 and 17.17 cm and an average degree of variability.

There were approximately similar values for plant height of the birdsfoot trefoil when it mixes with perennial ryegrass (36.49cm), smooth–stalked meadow grass (36.71cm), orchagrdgrass (36.46cm) and Wheatgrass (36.34 cm). According to the values of the variational coefficient of height of the birdsfoot trefoil in the independent seed (29.78%) and mixes it with tall fescue (27.47%), perennial ryegrass (24.42%) and Wheatgrass was a high degree of variability, but in others it is average.

The degree of variability of wheat components was significantly higher than that of the birdsfoot trefoil at the height of indicator plants. The height of plants shall be amended under the influence of weather

conditions, the rate of growth, development of grasses interrelation and competitiveness of the components in grass composition indicative of received variation coefficients.

Following the dry mass yield *(Table 2)* it was defined that higher yields than the average for the period of study were obtained from mixtures of birdsfoot trefoil with timothy, tall fescue, bromegrass, tall fescue, orchagrdgrassand red fescue, respectively 10.29; 8.93, and 8.95; 9.29; 8. 45 and 9.55 t.ha^{-1}. During the study with maximum values were mixtures of birdsfoot trefoil with timothy (16.41 t.ha^{-1}), red fescue (15.35 t.ha^{-1}) and bromegrass (15.30 t.ha^{-1}).

The mixture of birdsfoot trefoil and wheatgrass was lowest yield (12. 48 t.ha^{-1}).

The variation coefficients indicating yields stability showed that it was best expressed in the mixture of birdsfoot trefoil and tall fescue (CV=45.4%) and orchagrdgrass(CV=48.6%).

Table 2.

Arithmetic average (x), minimum and maximum values and variation coefficient (CV) of the dry mass yield mean for the period

Variants	t.ha^{-1}			
	min	max	x	VC
birdsfoot trefoil (St)	3.40	12.23	8.35	45.2
birdsfoot trefoil+ tall fescue	3.29	12.94	8.93	45.4
birdsfoot trefoil+perenial ryegrass	2.90	12.35	7.50	52.2
birdsfoot trefoil+ timothy	3.22	16.41	10.29	52.7
birdsfoot trefoil+lromegrass	3.12	15.30	8.95	55.7
birdsfoot trefoil+smooth–stalked meadow grass	3.07	14.92	9.29	52.2
birdsfoot trefoil+orchagrdgrass	3.05	13.06	8.45	48.6
birdsfoot trefoil+red fescue	2.90	15.35	9.55	53.5
birdsfoot trefoil+wheatgrass	2.89	12.48	7.75	50.7

There were no major differences between grass mixtures on the indicator of crude protein *(Table 3)*. With the highest crude protein content was independent birdsfoot trefoil single sward (19.09%).

The highest crude protein content was established in the mixture birdsfoot trefoil and Wheatgrass, with average alue 16.62%, and minimum and maximum values, respectively 12.04 and 19.53%.

The Mixture ofbirdsfoot trefoil with Timothy was 13.45% crude protein and values of all other blends were approximately similar. In the mixtures of birdsfoot trefoil and red fescue and perennial ryegrass were lower values and mixtures of birdsfoot trefoil and perennial ryegrass, timothy brome–grass, tall fescue, Cocksfoot were close values for crude fiber content.

With this feature all mixtures and single sward birdsfoot trefoil show a high degree of variation.

In sward birdsfoot trefoil was reported variation coefficient CV=29.69%, and in mixtures, it ranged from 21.65% in the mixture birdsfoot trefoil and perennial ryegrass to 33.73% in the mixture with brome–grass. In single sward birdsfoot trefoil, so all mixtures with the cereal grasses was minor differences the crude ash content.

Table 3.

Arithmetic average (x), minimum and maximum values and variation coefficient (CV) of the crude protein, crude fiber, crude ash

Variants	Crude protein				Crude fiber				Crude ash			
	min	max	x	vc	min	max	x	vc	min	max	x	vc
birdsfoot trefoil (St)	17.6	20.1	19.1	5.7	20.2	36.4	27.4	22.7	7.4	8.5	8.1	6.2
birdsfoot trefoil + tall fescue	7.6	17.9	14.4	32.0	22.8	37.2	28.5	21.6	6.7	9.8	8.0	16.0
birdsfoot trefoil+perenial ryegrass	9.4	18.2	15.0	27.0	22.9	44.2	32.6	27.4	7.0	10.5	8.5	19.5
birdsfoot trefoil + timothy	7.3	16.7	13.4	31.7	22.1	45.8	31.4	32.2	5.7	9.3	7.6	22.7
birdsfoot trefoil+lromegrass	8.6	18.8	14.7	29.4	22.7	45.9	31.0	33.7	5.2	8.9	7.6	21.4
birdsfoot trefoil+smooth–stalked meadow grass	9.6	17.9	14.8	25.7	21.9	41.1	31.2	25.6	7.4	9.9	8.7	12.2
birdsfoot trefoil+orchagrdgrass	8.5	16.2	13.5	25.4	25.2	47.0	33.4	28.3	5.8	10.1	8.1	22.3
birdsfoot trefoil+ red fescue	7.8	18.1	14.7	32.0	18.7	31.9	25.3	23.6	7.4	9.1	8.1	9.7
birdsfoot trefoil+wheatgrass	12.0	19.5	16.6	19.4	22.3	39.0	29.0	24.4	5.4	8.4	7.3	18.1

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According to the values of independent variational coefficient the birdsfoot trefoil was very low degree of variability in this parameter (CV=6.2%), mixtures of a birdsfoot trefoil with red fescue with low (CV=9.73%), with tall fescue (CV=16.05%) and smooth–stalked meadow grass (CV=12.17%), with perennial ryegrass (CV=19.55%,) and Wheatgrass (CV=18.13%,)–average, but with Timothy (CV=22.71%), brome–grass (CV=21.37%) and orchagrdgrass (CV=22.34%)–high.

The lower values for calcium content were established of all mixtures than the standard. This indicator showed significant variation between the variants.

The highest calcium *(Table 4)* content was a mixture of birdsfoot trefoil with wheatgrass 1.44%, Followed by the mixture birdsfoot trefoil and tall fescue–1.39%.

According to the variation coefficient of the degree of variability in these two mixtures was high, and with all mixtures very high. The content of phosphorus ranged from 0.241% to 0.374%.

The degree of variability in the mixture of birdsfoot trefoil and tall fescue was high, and in all other mixtures, very high.

From the correlations dependences *(Table 5)* found that the investigated parameters at individual variations were considerable degree of dependence.

The weak positive correlation was established in height of the birdsfoot trefoil in its mixtures of Cocksfoot (r=0.3581), red (r=0.2359) and tall fescue (r=0.25854).

The cereal grasses were the highest correlation coefficient in the height of birdsfoot trefoil and wheatgrass (r=0.6898).

With a very weak positive correlation was mixture of birdsfoot trefoil and tall fescue (r=0.0290) and Cocksfoot (r = 0.0533).

The values of crude protein in all variants were negative correlation coefficient.

The correlation coefficient of the compound with crude fiber content was very positive and strong correlation.

The mixture of birdsfoot trefoil and red fescue exhibits slight negative dependence on fiber content.

Table 4.

Arithmetic average (x), minimum and maximum values and variation coefficient (CV) of the calcium and phosphorus

Variants	Ca				P			
	min	max	x	vc	min	max	x	VC
birdsfoot trefoil (St)	1.351	3.443	2.042	46.6	0.147	0.515	0.335	46.8
birdsfoot trefoil + tall fescue	0.694	2.011	1.393	38.9	0.213	0.529	0.374	42.2
birdsfoot trefoil+perenial ryegrass	0.691	2.47	1.223	69.2	0.136	0.488	0.292	61.2
birdsfoot trefoil + timothy	0.523	1.275	0.914	44.1	0.099	0.515	0.292	67.7
birdsfoot trefoil+lromegrass	0.881	1.921	1.323	35.6	0.082	0.582	0.325	65.8
birdsfoot trefoil+smooth–stalked meadow grass	0.481	1.743	1.234	43.3	0.268	0.448	0.331	24.2
birdsfoot trefoil +orchagrdgrass	0.636	1.875	1.251	42.0	0.078	0.444	0.268	65.7
birdsfoot trefoil+ red fescue	0.465	1.405	0.821	62.4	0.082	0.401	0.259	62.6
birdsfoot trefoil+wheatgrass	0.901	1.984	1.444	36.4	0.083	0.395	0.241	55.3

Table 5.

Correlation coefficients between Dry mass yield and plant height,Crude protein and Crude fiber

Variants	Plant height (cm) of birdsfoot trefoil	Plant height (cm) of Grass components	% Crude protein	Crude fiber
birdsfoot trefoil (St)	–0.40746		–0.45293	0.614074
birdsfoot trefoil+tall fescue	0.25854	0.02909	–0.79537	0.865784
birdsfoot trefoil +perenial ryegrass	–0.60331	–0.14202	–0.90235	0.931825
birdsfoot trefoil + timothy	0.057197	–0.16447	–0.75084	0.918748
birdsfoot trefoil +lromegrass	0.014716	–0.25318	–0.96685	0.933826
birdsfoot trefoil +smooth–stalked meadow grass	–0.27847	–0.14813	–0.79601	0.978976
birdsfoot trefoil+orchagrdgrass	0.358136	–0.53343	–0.86396	0.900123
birdsfoot trefoil + red fescue	0.235915	–0.13509	–0.72407	–0.13526
birdsfoot trefoil +wheatgrass	–0.2057	0.689845	–0.62883	0.950881

Conclusions

The height of plants shall be amended under the influence of weather conditions, the rate of growth and development of grasses interrelation and competitiveness of the components in grass composition indicative of received

Variation coefficients. The production of birdsfoot trefoil and grass types varied with regard to treatments and years.

The variation coefficients indicating yields stability showed that it was best expressed in the mixture of birdsfoot trefoil and tall fescue (CV=45.42%) andorchagrdgrass (CV=48.65%).

The values of crude protein in all variants were negative correlation coefficient.

The correlation coefficient of the compound with crude fiber content was very positive and strong correlation.

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