

Productivity and Botanical Composition of a Mixed Sward of Birdsfoot Trefoil and Red Fescue Depending on the Term of Sowing and Proportion of Components

Boriana Churkova

Institute of Mountain Stockbreeding and Agriculture,
281, Vasil Levski str., Troyan, 5600, Bulgaria
Email: bchurkova@abv.bg

Abstract – The experiment includes the period 2010-2013. It was carried on a light grey pseudopodsolic soil in the experimental field of RIMSA - Troyan. The aim of present study is to determine the productivity and botanical composition of a mixed sward of birdsfoot trefoil and red fescue depending on the term of sowing and proportion of components. The following variants were studied: Factor A - terms of sowing: a_1 - 20th March - 10th April (spring) and a_2 - 20th August - 10th September (summer) and Factor B - percentage proportion: B_1 - 25% birdsfoot trefoil + 75% red fescue; B_2 - 50% birdsfoot trefoil + 50% red fescue and B_3 - 75% birdsfoot trefoil + 25% red fescue.

Results showed that the factors such as a term for sowing and proportion of components in the sward had an influence over productivity, botanical composition and the height of the mixed sward of birdsfoot trefoil and red fescue.

The optimal term for sowing of a mixed sward of birdsfoot trefoil and red fescue with the aim to obtain dry mass was 20th March - 10th April. The later summer sowing led to decrease in yield. With the increase of the percentage participation of birdsfoot trefoil in the sward from 25% to 75%, the dry mass yield grew up. In percentage proportion of birdsfoot trefoil and red fescue 75:25 average for the study period, the dry mass yield was 915.6 t.ha⁻¹, and the exceed in relation to control was by 12.2%.

The height of birdsfoot trefoil stems was influenced by the term for sowing and they had maximum values with the same grass mixture composition, to which also corresponded a maximum productivity.

The percentage of birdsfoot trefoil and red fescue followed the course of sowing during the three years of the experimental period. The spring sowing had favourable influence over the percentage participation of birdsfoot trefoil and red fescue in the sward.

Keywords – Grass Mixture of Birdsfoot Trefoil and Red Fescue, Productivity, Botanical Composition.

I. INTRODUCTION

Growing of legume and grasses in mixed swards have a number of advantages in comparison with the individual crops. Their living together changes the general structure of the crop, improves the vertical distribution of the root mass along the soil horizons and the layer disposition of the vegetative organs, increases photosynthesis production and raises yields from the obtained biomass [1, 2, 3].

Birdsfoot trefoil and red fescue are appropriate components for highly productive swards. The ordinary birdsfoot trefoil (*Lotus corniculatus L.*) is a perennial legume species, with environmental and biological characteristics, which gives it an advantage over the rest of

the legumes. It exceeds alfalfa and clover in regard to resistance to grazing and stamping, durability, drought resistance, resistance to acids and infertile soils, with a low content of P and high content of Al and Mn [4, 5]. Red fescue is the predominant and one of the most appropriate components for a joint cultivation with birdsfoot trefoil [6, 7].

For the foothill region conditions of the country, the perennial artificial swards represent an important, but an insufficiently studied reserve for providing animals with nourishing forage. Therefore for this purpose it is necessary to determine not only the appropriate species in the mixed swards, but also the main parameters of the agrotechnics in their cultivation. One of the ways to ensure high yield and the quality of forage is to optimize the term for sowing and proportion of components in the sward. According to [8], the optimal sowing term is directly related to the necessary temperature and availability of water resources in the particular region. A traditional way for cultivation of mixed crops of forage grasses is their sowing in spring [9], because of which in years of early spring droughts, low and unstable yields are obtained. Good results are also given by sowing in the end of summer and beginning of autumn. The great summer heat has already passed during that period, plants have taken roots, they have branched out, and accumulated enough spare nutrients before cold to come, as result in the next year they grow up successfully mighty and fast, they become ready for harvesting earlier and give high yields of green mass and hay with less weeds. The advantage of summer and autumn sowing is also the significantly easier endurance during summer droughts and other unfavourable conditions. For the conditions of Strandzha Mountain, grasses establish the best sward at late autumn sowing term [10].

The proportion of grasses to legumes in the sward is regulated by the biological characteristics of species, their mutual tolerance, competitiveness, aggressiveness, durability and conditions of habitats – soil conditions, exposure, level of fertilization, climate factors etc. [11]. The more frequent drought in spring, the scarce studies in relation to sowing terms and the percentage participation of components in the sward, as well as the interaction of both factors gives rise to the need for additional researches of similar character.

The aim of present study was to determine the productivity and botanical composition of sward of birdsfoot trefoil and red fescue depending on the term of sowing and the proportion of components.

II. MATERIALS AND METHODS

The experiment was carried out during 2010-2013 according to the block method in 4 replications, with a size of the experimental plot of 5m² on light grey pseudopodsolic soil in the experimental field of RIMSA - Troyan. The sowing was carried with birdsfoot trefoil Targovishte 1 cultivar and red fescue of local origin. The sowing preparation of the area was implemented in accordance with the technology that was adopted by the Institute for establishment of artificial sward.

The sowing was performed manually, in a broadcasting manner with a sowing rate for the different grass species, recalculated depending on the economic value and percentage participation in the sowing rate.

The following variants were studied: Factor A - term for sowing

a₁ – 20th March - 10th April

a₂ - 20th August - 10th September (summer)

Factor B - percentage proportion

b₁ - 25% birdsfoot trefoil + 75% red fescue

b₂ - 50% birdsfoot trefoil + 50% red fescue

b₃ - 75% birdsfoot trefoil + 25% red fescue

For the control, the variant (variant 2) with proportion of components 50:50 and spring sowing was adopted.

The following indicators were reported: stem height of the sown grasses (cm), dry mass yield (t.ha.⁻¹) and botanical composition of the sward (%).

Dry mass yield

Dry mass yield was determined through drying the average samples (200g) till they reached a permanent weight at 105°C in relation to new growths, years and average for the experimental period and calculated on the base of green mass yield and percentage of dry matter in the same.

Botanical composition of the sward

The botanical composition of the sward was determined in regard to weight and calculated in percentage participation of the sown grasses and weeds. The sward harvesting was performed at the stage of budding – beginning of flowering of birdsfoot trefoil. During the first year were reported the indicators only in variants (var. 1, 2 and 3) sown in spring, and in the next years of all variants.

Stem height of the sown grasses

The stem height was determined immediately before gathering of each new growth of 40 plants of birdsfoot trefoil and red fescue, as plants, from the soil surface to the highest stems, were measured at 4 points along both diagonals of each plot.

Statistical analysis

The experimental data were processed statistically (Lidanski, 1988) using software products Microsoft Excel. The parameters were determined immediately before harvesting of each cut. The degree of variation of parameters was determined through variation coefficient according to the scheme of Mamaev [12], up to 7% - very low, 7.1 to 12% low, 12.1 to 20% moderate; 20.1 - 40% high; over 40% - very high. Correlations of Brave and Pirson, were calculated to prove the relations between the different characteristics and their influence on productivity as well as between them.

III. RESULTS AND DISCUSSION

Meteorological data comprising temperature and rainfall were different during the years of the experimental period. During the four years were observed years with spring droughts and such of intensive rainfalls. The spring sowing of grasses sowed in 2010 occurred under conditions of normal humidity at average amount of monthly rainfall for March and April, respectively 76.9 and 112.6 l/m², and average monthly temperature in the range of 5.3 to 10.8°C. These favourable conditions gave the opportunity for even seed sprouting and formation of two cuttings in the year of sowing and to reach in time the different phenophases of birdsfoot trefoil and red fescue development. The sowing term had an influence over the continuation of phenophase, and growth rate and development of birdsfoot trefoil and red fescue. A quicker sprouting rate was reported in the spring sowing in comparison with the summer one, which could be explained by the more favourable agrometeorological and soil conditions for germination and sprouting of seeds. The delay of sprouting during summer sowing was due to less rainfall amount in the months of August (40.9 l/m²) and September (38.5 l/m²) and the higher average daily temperature (21.7 and 19.3°C). The summer sowing contributed to normal rooting and wintering of the sown grasses.

Table 1: Dry mass yield (t ha⁻¹) by years and average for the period

Variants	2010		2011		2012		2013		Average for the Period	
	t ha ⁻¹	%	t ha ⁻¹	%	t ha ⁻¹	%	t ha ⁻¹	%	t ha ⁻¹	%
a ₁ + B ₁	30.4	95.0 -	10.8	96.7-	89.9-	99.3 -	88.4	96.5-	79.3	97.2-
a ₁ + B ₂	32.0	100.0-	11.2	100.0	90.5-	100.0	91.7	100.0-	81.6	100.0-
a ₁ + B ₃	30.6	95.6-	12.6	112.3-	116.6++	1288++	92.9	101.4-	91.6	112.2-
a ₂ + B ₁			9.5	85.4-	85.7-	947-	73.2	79.9	63.7	78.0-
a ₂ + B ₂			10.4	93.1-	99.7-	1101-	85.5	93.3-	72.4	88.7-
a ₂ + B ₃			10.1	90.5-	94.5-	1045-	85.2	92.9-	70.3	86.1-
LSD 5%	5.7	18.0	20.9	18.7	14.6	16.2	17.9	19.6	15.9	20.1
LSD 1%	8.7	27.2	29.0	25.9	20.2	22.3	24.9	27.2	22.0	27.8
LSD0.1%	14.0	43.7	40.1	35.8	27.8	30.7	34.4	37.5	30.4	38.4

LSD - Statistical warranted of differences

Dry mass yield

In the year of sowing only dry mass yield (Table 1) was reported in spring sowing, which did not differ significantly in the different variants. In sowing with percentage proportion 25% birdsfoot trefoil + 75% red fescue (variant 1) and 75% birdsfoot trefoil + 25% red fescue (variant 3) was obtained relatively equal yield, respectively 30.4 and 30.6 t ha.⁻¹ Insignificantly higher was the productivity in the spring sowing and the percentage proportion 50 % birdsfoot trefoil + 50% red fescue (variant 2).

In the second year in the spring sowing was observed a more accelerated development of both cultures in the three variants, which was noticeable by the earlier entering in haymaking ripeness of the sward in comparison with the summer sowing. The harvested dry mass yields of the variants of the first sowing term (spring) were higher than these in the second (summer) term. The normal rainfall amount in combination with favourable temperatures during the whole vegetative period contributed for obtaining high yields. The mixture of birdsfoot trefoil and red fescue in proportion of components 75:25 (variant 3) showed yield that exceeded the control by 12.3%, and for all other variants yield was lower than the control. In the variants sowed in spring was observed a tendency to increase the dry mass yield with increasing the percentage participation of birdsfoot trefoil in the sward. The plants from spring sowing terms (variant 1, 2 and 3) had greater sward density and greater number of branches of the birdsfoot trefoil, greater values for the stem height, which corresponded to the higher yield that was obtained for these variants. Thus in proportion of components birdsfoot trefoil 25% + red fescue 75% (variant 1), the yield was 108.4 t ha.⁻¹, and in proportion 75:25 (variant 3) it reached 126.0 t ha.⁻¹. This could be explained by reaching the maximum productive capabilities of birdsfoot trefoil in its second year of development. The high dry mass yield in variants with spring sowing makes an impression. As first yielding year, the obtained yields in variants 4, 5 and 6 with percentage proportions of birdsfoot trefoil and red fescue 25:75, 50:50 and 75:25 were comparatively high, but below these of the control. The realized yields were respectively 957.5 (variant 4), 104.4 (variant 5) and 101.4 (variant 6) t.ha.⁻¹. There was no proof of the differences for both terms of sowing in dry mass yield in comparison with those obtained from the control variant.

In the third year the mixture of birdsfoot trefoil and red fescue, which was sown in the spring, in proportion of components 75:25, realized the highest dry mass yield, respectively by 28.8% over the yield from the control. The sward with proportion of components 50:50 (variant 5) in the summer sowing showed exceed by 10.1%. Lower yield than that of control was reported only in the sward that was sown in summer in proportion of components of birdsfoot trefoil and red fescue 25:75 (variant 4). The mathematic data treatment showed that the differences in comparison with yield obtained from the control variant were statistically very well-proven in the spring sowing with proportion of birdsfoot trefoil and red fescue 75:25 (variant 3). For the summer sowing, in the three

percentage proportions of components in the sward, there was no proof of the differences in the dry mass yield in comparison with that obtained from the control variant.

The sward productivity remained high for all variants in the fourth year from the experimental period. During that harvesting year, the factor of term of sowing was more slightly expressed in comparison with the factor of proportion of components in sward. Again variants with spring sowing were more productive than summer ones, as the differences in productivity was insignificant. For spring sowing they ranged from 88.4 to 92.9 t ha.⁻¹, as although insignificant superiority was observed in the variant with the increase of the percentage participation of birdsfoot trefoil in the sward (variant 3). The mixture of birdsfoot trefoil and red fescue in proportion of components 75:25 (variant 3), which was sown in spring, showed yield that exceeded insignificantly the control, barely by 1.41%. For the summer sowing, the yield for all percentage proportions was considerably higher than that of control.

Average for the period of study, the results showed that the optimum term for sowing of the mixture of birdsfoot trefoil and red fescue was 20th March-10th April (spring sowing). At that period, the forage yield grew with the increase of the percentage participation of birdsfoot trefoil in the sward from 25% to 75%. It was the highest with percentage proportion of birdsfoot trefoil and red fescue 75:25, (91.6 t.ha.⁻¹ - variant 3) as a result the productivity reached 91.1 t ha.⁻¹, and the exceed in comparison with control was by 12.2%. In the summer sowing, regardless of the percentage proportion of components in the mixture, yields were considerably lower than these of the control. For later sowing term, the highest dry mass yield (72.4 t ha.⁻¹) realized the mixture of birdsfoot trefoil and red fescue with proportion 50:50. Obtained results showed that both the factor term of sowing and the factor of proportion of components in the sward had an influence over the productivity of a mixed sward of birdsfoot trefoil and red fescue.

Botanical composition of the sward

The sward botanical composition in the year of sowing represented in Table 3 showed that birdsfoot trefoil had a greatest share in the spring sowing and percentage proportion of 75% birdsfoot trefoil + 25% red fescue. The participation of red fescue was low for all variants, which was due to the slower rate of growth and development. In the first year, in the spring sowing, the participation of birdsfoot trefoil and red fescue corresponded to their percentage proportions in the way of sowing. Birdsfoot trefoil increased from first to third variant, and the red fescue decreased. The weed infestation percentage was comparatively high (26.3%) in the sowing of birdsfoot trefoil and red fescue in composition 25:75.

In the second year, the birdsfoot trefoil took the greatest share (73.6%) in the spring sowing with a percentage proportion 75% birdsfoot trefoil + 25% red fescue. The red fescue in the same variant was with the lowest percentage in the sward, respectively 7.5%, and the weed infestation percentage was comparatively high (18.9%). The summer sowing of a mixed sward in composition 25%

birdsfoot trefoil + 75% red fescue (variant 4) had the lowest weed infestation percentage (5.3%). Regarding the

weed infestation degree, the effect of summer sowing was significantly better than summer one.

Table 2: Botanical composition of sward in weight percent

Variants	2010			2011			2012			2013		
	Birds foot trefoil	Red fescue	Weeds	Birds foot trefoil	Red fescue	Weeds	Birds foot trefoil	Red fescue	Weeds	Birds foot trefoil	Red fescue	Weeds
a ₁ + B ₁	58.5	15.2	26.3	47.2	38.2	14.6	51.7	28.1	20.2	41.2	38.1	20.7
a ₁ + B ₂	47.1	10.8	42.1	46.9	42.9	10.2	69.1	16.4	14.5	36.4	33.3	30.3
a ₁ + B ₃	82.3	7.1	10.6	73.6	7.5	18.9	79.5	6.8	13.7	45.5	33.3	21.2
a ₂ + B ₁				70.2	24.5	5.3	55.3	38.2	6.5	44.4	13.9	41.7
a ₂ + B ₂				63.3	26.7	10.0	59.4	32.7	7.9	34.8	49.3	15.9
a ₂ + B ₃				70.9	21.3	7.9	66.7	28.4	4.9	45.5	36.4	18.1

In the third year both in spring and summer sowing, the participation of components in the sward followed the course of sowing of the sown grasses in the corresponding percentage proportions. The birdsfoot trefoil had the greatest share (79.5%) in the spring sowing and with percentage proportion 75% + 25% red fescue (variant 3). Red fescue in the same variant had the smallest share, respectively 6.8%, and the weed infestation percentage was 13.7%. The summer sowing for all variants showed lower degree of weed infestation than the spring one. A significant difference in the percentage participation of weeds among variants was not found, but the share of weeds in the mixed sward in composition 75% birdsfoot trefoil + 25% red fescue (variant 6) had the lowest

percentage of weed infestation (4.9%), which corresponded with the highest sward productivity.

In the fourth year, in the first new growth, the difference in the percentage participation of birdsfoot trefoil was slightly expressed for the different percentage proportions of components in the sward. For both terms of sowing, the birdsfoot trefoil had the highest percentage in the sward (45.5%) with proportion of components in the sward 75% birdsfoot trefoil + 25% red fescue (variant 3 and 6) With the exception of variant 4, where the red fescue were presented in the sward by 13.9%, for the various variants was not found a difference in the percentage of red fescue.

Stem height of the sown grasses

Table 3: Stems height of grass sowed by years (cm)

Variants	2010		2011		2012		2013	
	Birdsfoot trefoil	Red fescue	Birdsfoot trefoil	Red fescue	Birdsfoot trefoil	Red fescue	Birdsfoot trefoil	Red fescue
a ₁ + B ₁	18.2	11.5	47.2	63.1	43.8	49.7	39,68	55,20
a ₁ + B ₂	21.4	22.1	44.1	64.5	46.4	50.4	38,35	57,65
a ₁ + B ₃	23.9	24.2	49.2	50.2	47.1	51.6	41,50	55,73
a ₂ + B ₁			42.1	52.9	43.8	43.2	35,23	43,83
a ₂ + B ₂			41.2	52.8	45.5	44.7	38,05	48,45
a ₂ + B ₃			41.6	50.5	46.1	43.0	32,20	38,18
X	21.2	19.3	44.2	55.7	45.5	47.1	37.5	49.8
SD	2.9	6.8	3.3	6.4	1.4	3.9	3.3	7.7
VC	13.5	35.3	7.4	11.6	3.1	8.3	8.8	15.5
Min	23.9	24.2	41.2	50.2	43.8	43.0	41.5	57.6
Max	18.2	11.5	49.2	64.6	47.1	51.6	32.2	38.2

X – mean value; Min – minimum value; Max – maximum value; CV – coefficient of variation, SD – statistical deviation

The measured heights of the sown components (Table 3) in 1, 2 and 3 variants had comparatively low values, which gave the explanation for the obtained low dry mass yield in the year of sowing. The heights of birdsfoot trefoil stems both in the second and third harvesting years had the maximum values in the spring sowing and with proportion of birdsfoot trefoil: red fescue 75:25, and were respectively 49.2; 47.1 and 48.1 cm, as the differences among them were insignificant. This shows that the factor percentage proportion of components did not have an essential influence over the height of plants, but the influence of term for sowing was considerable. According

to the measured values of the variation coefficient, the degree of variability in relation to the stem height indicator for birdsfoot trefoil was very low, respectively 7.4 and 3.1 for 2011 and 2012, and for red fescue was low, with values of VC = 11.6 and 8.3. For the summer sowing, the difference in height in the different percentage proportions of components in the mixture was inessential. In 2012 the values of stem height of birdsfoot trefoil were increased with the increase of percentage proportion of birdsfoot trefoil in the sward. Thus in the summer sowing and the percentage proportion of birdsfoot trefoil and red fescue 75:25 (variant 6), their height reached 46.1 cm. The high

values of stems of the sown components during these two years explained the relatively high dry mass yield. Red fescue stems in the second year were taller than in the third one. The spring sowing again increased their rate of growing. In the second year, the highest stems had red fescue in the mixture in composition 50% birdsfoot trefoil + 50% red fescue and respectively 64.5 cm. In the fourth year, the stems in the spring sowing for all percentage proportions of components in the sward exceeded in height the stems from the summer sowing. The greatest height in the first term for sowing, the plants reached in proportion between birdsfoot trefoil and red fescue 75:25 (variant 3), as respectively they were 41.50 cm. For the three variants of the spring sowing, the stems of red fescue had higher values than stems of red fescue in the summer sowing.

IV. CONCLUSION

The optimal term for sowing of a mixed sward of birdsfoot trefoil and red fescue with the aim to obtain dry mass was 20th March - 10th April. The later summer sowing leads to decrease in yield. With the increase of the percentage participation of birdsfoot trefoil in the sward from 25% to 75%, the dry mass yield grows up. In percentage proportion of birdsfoot trefoil and red fescue 75:25 average for the study period, the dry mass yield is 91.6 t ha⁻¹, and the exceed in relation to control is by 12.2%.

The height of birdsfoot trefoil stems was influenced by the term for sowing and they have maximum values in the same composition of the grass mixture, to which also corresponds maximum productivity.

The percentage of birdsfoot trefoil and the red fescue follows the course of sowing during the three years of the experimental period. The spring sowing had favourable influence over the percentage participation of birdsfoot trefoil and red fescue in the sward.

REFERENCES

- [1] R. A Turkington, P. B. Cavers, L. W. Aarssen, „Neighbour relationships in grass-legume communities: Interspecific contacts in four communities near London, Ontario”, 1987. *Journal of Botany*, 55, 21, pp. 2701-1711.
- [2] M. A. Sanderson, B. F Tracy, R. H Skinner, D. Gustine and R. Byers, „Changes in the plant species composition of northeastern grazing lands during the 20 th. Century”. In *Proc. 1 st Natl. Conf. On Grazing Lands. Las Vegas. NV. 5-8. Dec.2000 Natl. Assoc. Conserv.Districts, Wachington. Dc.*, pp. 365-373
- [3] R. A. Zemenchik, K. A . Albrecht and M.K. Schultz, „Improved nutritive value of Kura clover and birdsfoot trefoil-grass mixtures compared with grass monocultures”, 2002. *Agronomy journal*, 94, pp. 1131-1138.
- [4] J.J. Steiner and P.R. Beuselinck, „Birdsfoot trefoil origins and germplasm diversity”. In (ed.) *Trefoil: The science and technology of Lotus ASA-CSSA*, 2000. *Spec. Publ. 28. Madison, WI.*, pp. 81-96.
- [5] W. Grant and G. Marten, „Birdsfoot trefoil. In Heath, Barnes, Metcalfe d.s. (Eds.) *Forages: the science of grasslands agriculture*”, 1985. *Iowa State University Press, Ames*, pp. 98-108.
- [6] B. Chourkova, „Botanical composition and productivity of birdsfoot trefoil in mixtures with Meadow Grasses in Bulgaria”, 2007. *Journal of Balkan ecology*, vol. 10, 1, pp. 57-61.

- [7] D. Mitev and G. Naydenova, „Persistency of artificial swards with participation of red fescue on the slopes of the Central Balkan mountains V. State of a mixed sward of red fescue and birdsfoot trefoil”, *Journal of Mountain Agriculture on the Balkans*, 2008. vol. 11, 7, pp. 1342-1352.
- [8] K. Belperchinov and B. Churkova „Influence of terms of sowing over productivity and chemical composition of a grass mixture under conditions of Troyan region”, *Journal of Mountain Agriculture on the Balkans*, 2005. vol. 8, 4, pp 473-484.
- [9] K. Stoeva, „Study on terms of sowing of perennial grasses and grass mixtures”, *Plant science*, 1995. 6, pp. 156-158.
- [10] K. Stoeva and D. Mitev, „Specifying terms of sowing of perennial grasses under conditions of Strandzha Mountain”, 2007. *Field crops studies*, vol. IV, 2, pp. 363-367.
- [11] K., Kostov, T. Totev. and K. Koev, „Specifying relationships of cock's foot with birdsfoot trefoil and red clover in relation to yield and production quality”, 1987. *Plant science*, 11 pp. 62-68.
- [12] T. Lidanski, „Statistical methods in biology and agriculture”, 1988. *Zemizdat, Sofia*, pp. 150-187.

AUTHOR'S PROFILE



Assoc. Prof. Dr. Boriana Churkova

I was born on 28-04-1963 in the village of Vrabevo, Lovech district, Bulgaria.

I am M.Sc. in Husbandry in 1986 from Agrarian University in Plovdiv, Bulgaria, PhD in 1999 and Assoc. Prof. in 2003 - both in Forage Production and

Grasslands from the Institute of Mountain Stockbreeding and Agriculture in Troyan, Bulgaria.