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INFLUENCE OF MINERAL FERTILIZATION ON SOME BIOLOGICAL AND PRODUCTIVE INDICATORS OF NATURAL MEADOW OF *AGROSTIS CAPILLARIS-FESTUCA FALLAX* TYPE IN THE RHODOPE MOUNTAINS (SOUTHERN BULGARIA)

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Abstract: The experiment with natural meadow of *Agrostis capillaris - Festuca fallax* type in Rhodope Mountains (Smolyan region, Southern Bulgaria) shows that according to fertilization variants there is a clear tendency towards earlier start of active vegetation and its next phenophases. Most and almost equal amounts of dry biomass (4.38 and 4.31 $t.ha^{-1}$) were reported in fertilization with $N_{160}P_{80}K_{80}$ and $N_{160}P_{80}$, which exceeded the unfertilized control by 128.12 and 124.48%, respectively. Compared with unfertilized variant, the crude protein content increased in all fertilizing variants, as in complete mineral fertilization with N_{80-160} accumulates the crudest protein - respectively 314 $g.kg^{-1}$ and 318 $g.kg^{-1}$. As regards to other studying chemical indicators of the forage (crude fiber, crude fat, crude ash and nitrogen-free extract substances) the mineral fertilization also had an expressed positive effect.

Key words: meadow, *Agrostis capillaris-Festuca fallax* type, fertilization, bioproductivity, the Rhodope Mountains.

Introduction

The meadows and pastures in the mountainous regions of Bulgaria have a highly productive potential as a basic and only one source of obtaining roughage for refute or pasture breeding of animals (mainly sheep and cattle).

The natural meadows of *Agrostis capillaris-Festuca fallax* type in Bulgaria occupy an area of 50 783.3 ha, which is 22.66% of the total area of natural meadows in the country (224 145.8 ha). The natural pastures of this type amounted to 82 696 ha, which is 6.76% of the total area of natural pastures in the country (1 222 896.2 ha). In Smolyan region natural meadows of this type reached 56.8% of the total area of natural meadows in the region,and annually give about 1.5-2.0

t.ha^{-1} with good quality hay (in 100 kg hay containing 46 food unit and 3.41 kg digestible protein). The natural pastures of the same type here reached 39.2% of the total area of natural pastures in the region, giving an annual yield of 3.6-4.4 t.ha^{-1} green mass with good quality feed. *(Cheshmedjiev, 1976; Yakimova et al., 1977).*

Due to irrational use and low levels of applied agricultural machines, the condition of natural meadows and pastures in the region is unsatisfactory. Furthermore, the main reasons for their low forage productivity are specific vegetation of grass stands and available natural and environmental characteristics that are typical of the region such as weak soil reserve with essential nutrients, high soil acidity, irregular rainfall distribution, a high rough of country, etc.

The conducted multiplied studies in Bulgaria *(Totev, 1984; Pavlov, 1996 and others)* and abroad *(Kasper, 1971; Sur, 1975; Sung and Kim, 1985; Grandi et al., 1989; Giraldez et al., 1993 and others)* show that apart from specific natural characteristics the quality and quantity of biomass obtained from natural grasslands has been also influenced to a great extent by the level of enforcement. Mineral fertilization and its ways of use are among the most important in farming practices.

The purpose of this study was to identify the changes in productivity and chemical composition of forage biomass from natural meadow of *Agrostis capillaris-Festuca fallax* type in the Rhodope Mountains (near the town of Smolyan, Southern Bulgaria) under the influence of mineral fertilization with different rates and combinations of nitrogen, phosphorus and potassium fertilizers and dynamic of grass biomass accumulation during a period of vegetation and in different phenophases of grass growth.

Materials and Methods

The field experiment was conducted during the 1992-1994 period, on natural meadow of *Agrostis capillaris-Festuca fallax* type in the Rhodope Mountains (near the town of Smolyan, Southern Bulgaria) at 1100 m altitude. The soil in the area of experiment was a brown forest with light mechanical structure because the chemical composition was characterized by a middle reserve of humus and a low total nitrogen and phosphorus. Low values were established by water soluble forms of nitrogen, phosphorus and molybdenum and the reserve of water soluble forms of potassium and boron was optimum. The soil reaction was acidic.

The block-method was used in four repetitions and the harvesting plot area of 25 m^2 with the following fertilizer rates in kg per 1 ha as variants: 1. $N_0P_0K_0$ (unfertilized variant) – Control; fertilization variants: 2. N_{80}; 3. P_{80}; 4. K_{80}; 5. $N_{80}P_{80}$; 6. $N_{80}K_{80}$; 7. $P_{80}K_{80}$; 8. $N_{80}P_{80}K_{80}$; 9. N_{160}; 10. $N_{160}P_{80}$; 11. $N_{160}K_{80}$; 12. $N_{160}P_{80}K_{80}$. The fertilization was accomplished annually, in early spring and shortly before the beginning of active vegetation of grasses, with nitrogen (as ammonium nitrate), phosphorus (as superphosphate) and potassium (as potassium sulphate). The trial plots were hay-making by hand in full flowering phenophase of grasses.

During the conduction of the field experiment information about the following indicators was collected:

1. Time for passing of the main phenophases of grasses - through visual observation by Rudenko-method.
2. Growth swiftness of grasses – such as complete stalk shooting, ear-formation and full flowering phenophases – by date.
3. Dry mass (DM) yields (in t.ha^{-1}) - it was established by drying constant weight at 105^{0}C of 0.5 kg green mass samples, taken immediately after cutting each trial plot and repetition. It was reported for years and average for the experimental period.
4. Chemical composition of the absolutely dry matter – crude protein content (by Kieldahl-method); of crude fiber (by Kyushner and Haver-method); of crude fat – by ether extract; of nitrogen-free extract substances (NFES) – the amount difference among crude protein, crude fiber, crude fat and crude ash; of crude ash – by weighing.

The daily temperatures for each of the months in the Smolyan region for the 1977-1996 period characterize the region by mild winters, cool springs and summers without too much heat and with relatively warm autumn months. The temperature regime significantly influenced the growth of grasses the duration of vegetation period as well as the accumulation intensity of green mass and dry matter.

For the same 20-annual period the humidity was relatively high and annual rainfalls (1180.2 l/m^2) were almost two times more than the average amount of the country (620 l/m^2). The rainfall is unevenly distributed. There is clearly marked winter and spring-summer rainfall maximum, as rainfalls in April, May and June are crucial for the natural grasslands productivity. The rainfall reduction during July, August and September has a negative impact on productivity of grasslands.

Results and Discussion

Time for passing of the main grass phenophases. From Table 1 it is obvious, that in 1992 the growing-up phenophase in the control occurred on 05.05., while self-fertilization with nitrogen (regardless of its rate), with phosphorus or potassium, in combined fertilization (var. 5-7 and var. 10-11) and in complete mineral fertilization (var. 8 and 12) – on 02.05.-03.05. Similar differences in control were observed in other stages. So, compared to fertilization variants the stalk shooting in var. 1 also occurred later – on 08.06., as against 05.06.-07.06. in self- and combined fertilization with lower rates (80 kg.ha^{-1}) and on 01.06.-02.06. in var. 8-12. That same year, the ear-emergence stage in the control also occurred later – only on 30.06., while in other variants varied from 20.06. to 22.06. (in complete mineral fertilization as well as self- and combined fertilization with N_{160}). In self- and combined fertilization with lower rates this stage occurred towards 25.06.-28.06.

Table 1. Time for passing of the main phenophases of grasses by years and dates.

Fertilization variants	Growing-up			Stalk shooting			Ear-formation			Flowering		
	1992	1993	1994	1992	1993	1994	1992	1993	1994	1992	1993	1994
1.$N_0P_0K_0$(Control)	05.05.	07.05.	08.05.	08.06.	07.06.	10.06.	30.06.	27.06.	04.07.	22.07.	23.07.	24.07.
2. N_{80}	03.05.	04.05.	05.05.	05.06.	04.06.	07.06.	25.06.	23.06.	28.06.	20.07.	19.07.	21.07.
3. P_{80}	03.05.	05.05.	06.05.	07.06.	07.06.	08.06.	28.06.	25.06.	03.07.	22.07.	22.07.	23.07.
4. K_{80}	02.05.	05.05.	07.05.	07.06.	06.06.	08.06.	28.06.	26.06.	04.07.	23.07.	20.07.	22.07.
5. $N_{80}P_{80}$	03.05.	04.05.	05.05.	05.06.	04.06.	06.06.	22.06.	23.06.	26.06.	18.07.	17.07.	19.07.
6.$N_{80}K_{80}$	02.05.	03.05.	05.05.	06.06.	05.06.	06.06.	26.06.	24.06.	27.06.	22.07.	20.07.	19.07.
7. $P_{80}K_{80}$	02.05.	05.05.	07.05.	07.06.	07.06.	08.06.	28.06.	25.06.	03.07.	21.07.	21.07.	22.07.
8.$N_{80}P_{80}K_{80}$	02.05.	02.05.	03.05.	02.06.	02.06.	03.06.	22.06.	23.06.	23.06.	14.07.	15.07.	16.07.
9. N_{160}	02.05.	03.05.	03.05.	01.06.	02.06.	01.06.	22.06.	22.06.	23.06.	18.07.	19.07.	18.07.
10. $N_{160}P_{80}$	03.05.	03.05.	04.05.	01.06.	01.06.	30.05.	21.06.	21.06.	21.06.	15.07.	13.07.	13.07.
11. $N_{160}K_{80}$	02.05.	03.05.	03.05.	02.06.	01.06.	01.06.	22.06.	22.06.	22.06.	14.07.	15.07.	15.07.
12.$N_{160}P_{80}K_{80}$	03.05.	03.05.	04.05.	01.06.	01.06.	02.06.	20.06.	21.06.	21.06.	13.07.	15.07.	14.07.

The full flowering stage occurred later in fertilization with K_{80}, P_{80}, $N_{80}K_{80}$, $P_{80}K_{80}$ and in unfertilized control – between 21.06.-23.06., and earliest in complete mineral fertilization (var. 12) and combined fertilization with N_{80}-$_{160}$ – during the 13.06.-18.06. period. Thus, fertilization with $N_{80}P_{80}K_{80}$, $N_{160}K_{80}$ and $N_{160}P_{80}$ reduced the time from grow-up beginning to full flowering of 7 days, and fertilization with $N_{160}P_{80}K_{80}$ - of 8 days. From Table 1 it is clear, that generally self-fertilization with nitrogen, phosphorus or potassium does not lead to significant differences needed for the main stages of grasses.

During next year (1993) unfertilized control phenophases occurred later than fertilization variants. As a result, the start of the grow-up in control occurred on 07.05., while the early onset of vegetation was found in fertilization with $N_{80}P_{80}K_{80}$ – still on 02.05.

The combined fertilization with lower and higher rates and complete fertilization with $N_{160}P_{80}K_{80}$ caused vegetation on 03.05., while self- and combined fertilization with $N_{80}P_{80}$ – on 04.06.-05.06. The next phenophase - the stalk shooting occurred later in the control and fertilization with P_{80} and $P_{80}K_{80}$ – on 07.06., and earliest in combined and complete mineral fertilization with N_{160} – still on 01.06., and other variants occupied an intermediate position.

The earliest ear-formation stage again occurred in self-, combined and complete mineral fertilization with N_{160} – on 21.06.-22.06., and later again in unfertilized control – barely on 27.06. In other fertilizing variants this stage occurred in the period 23.06.-26.06. The earliest full flowering stage was established in fertilization with $N_{160}P_{80}$ – still on 13.07., followed by var. 8, 11 and 12 – on 15.07., but the latest was the flowering of control variant – 8 days later (on 23.06.).

The other studying variants were in an intermediate position in relation to the occurrence of that stage. It is seen that in 1993 the complete mineral fertilization (вар. 8 and 12) reduced the time from growing-up to full flowering by 3 and 4 days, combined fertilization with $N_{80}P_{80}$ (var. 5) – by 3 days, combined fertilization with N_{160} (var. 10 and 11) – by 6 and 3 days, respectively, while self-fertilization (regardless of norm) occupied an intermediate position.

In the last year of study (1994) the growing-up phenophase again occurred later in the control variant – at 08.05., followed by self-fertilization with K_{80} and combined fertilization with $P_{80}K_{80}$ – of 07.05. The earliest occurrence of this stage was reported in fertilization with $N_{80}P_{80}K_{80}$, N_{160} and $N_{160}K_{80}$ – of 03.05., while the other studied variants ranged from 04.05. (var. 10 and 12) to 06.05. (var. 3). The next phenophase (the stalk shooting) occurred earliest (as early as 30.05.) in fertilization with $N_{160}P_{80}$, followed by var. 9 and 11 (fertilization with N_{160} and $N_{160}K_{80}$) – to 01.06., and latest again in unfertilized control – only 10.06. In other variants this stage occurred between the periods 02.06. (var. 12) – 08.06. (var. 3, 4 and 7). In most studying variants (eight) the next phenophase (the ear-formation) occurred in June (more on 21.06.) and it was established in fertilization with $N_{160}P_{80}$ and $N_{160}P_{80}K_{80}$, and latest in control and self-fertilization with K_{80} – only 04.07., followed by fertilization with P_{80} and $P_{80}K_{80}$ – on 03.07., while the other variants occupied an intermediate position regarding the occurrence of this phenophase. The same year, the full flowering occurred earliest after the complete mineral fertilization with $N_{160}P_{80}$ - still on 13.07., and latest (after 11 days) in control – 24.07., followed by self-fertilization with nitrogen, phosphorus or potassium (var. 2, 3 and 4) and combined fertilization with $P_{80}K_{80}$ – between 21.06 and 23.06. The same table shows that most of the time from the start of the growing-up phenophase to full flowering stage was reduced in fertilization with $N_{160}P_{80}$ – with 7 days, followed by complete mineral fertilization with $N_{160}P_{80}K_{80}$ and $N_{160}K_{80}$ – by 6 and 4 days, respectively.

In generalization, differences in the occurrence of the main phenophases are not only due to differences in application of mineral fertilizers (such as combinations and rates), but the existing weather conditions during the vegetation period of the correspondingly year. However, during the study, the fertilizing variant observed a clear trend towards earlier initiation of active vegetation and hence to an earlier onset of the next phenophase of grasses, although the predominant species in grass stand (*Agrostis capillaris*) is characterized by a slow growth.

Productive potential of the grass area. The results from Table 2 show that compared with unfertilized control the grass area productivity exceeded significantly in the studying fertilization variants as early as the first year of the experiment (1992). Thus, the obtained dry mass in self-fertilizing variant with nitrogen, phosphorus or potassium in rates 80 kg.ha^{-1} (var. 2, 3 and 4) exceeded unfertilized variant by 54.59, 35.20 and 14.79%, respectively. The combined fertilization with the same rates (var. 5, 6 and 7) increased in greater yields compared to the control – by 79.08, 68.37 and 55.10%, while the complete fertilization (var. 8) was double the excess – with 104.08%. Doubling the rate of nitrogen (160 kg.ha^{-1}), despite its own, double or triple combination (var. 9-12) resulted in an increase of dry biomass obtained from 4.04-4.41 t.ha^{-1}, which was more 106.12-125.00% compared with unfertilized control.

Table 2. Dry matter yields (t.ha^{-1}) by years and average for the 1992-1994 period.

Fertilization variants	1992		1993		1994		Average for the period		Proof
	t.ha^{-1}	%	t.ha^{-1}	%	t.ha^{-1}	%	t.ha^{-1}	%	
1. $N_0P_0K_0$ (Control)	1.96	100.00	1.73	100.00	2.07	100.00	1.92	100.00	-
2. N_{80}	3.03	154.59	2.82	163.00	2.96	142.99	2.94	153.12	+
3. P_{80}	2.65	135.20	2.46	142.20	2.61	126.09	2.57	133.85	-
4. K_{80}	2.25	114.79	2.02	116.76	2.11	101.93	2.13	110.94	-
5. $N_{80}P_{80}$	3.51	179.08	3.64	210.40	3.76	181.64	3.64	189.58	+++
6. $N_{80}K_{80}$	3.30	168.37	3.16	182.66	3.27	157.97	3.24	168.75	++
7. $P_{80}K_{80}$	3.04	155.10	2.91	168.21	2.98	143.96	2.98	155.21	+
8. $N_{80}P_{80}K_{80}$	4.00	204.08	3.98	230.06	4.08	197.10	4.02	209.37	+++
9. N_{160}	4.04	206.12	3.90	225.43	4.08	197.10	4.00	208.33	+++
10. $N_{160}P_{80}$	4.27	217.86	4.11	237.57	4.57	220.77	4.31	224.48	+++
11. $N_{160}K_{80}$	4.09	208.67	4.03	232.95	4.18	201.93	4.10	213.54	+++
12. $N_{160}P_{80}K_{80}$	4.41	225.00	4.22	243.93	4.50	217.39	4.38	228.12	+++

LSD 0.05
23.7
LSD 0.01
34.5

The same table shows that over the next year (1993) dry mass yields decreased in all variants compared with the previous year. So in the control variant there was 1.13 times decrease, in self-fertilizing with nitrogen, phosphorus or potassium in rates 80 kg.ha^{-1} – from 1.07 to 1.11 times, in the combined fertilization with the same rates (var. 6 and 7) – 1.04 times, in complete fertilization (var. 8) – 1.00 time. Doubling the rate of nitrogen, whether self-dependent, double or triple combination (var. 9-12) decrease was from 1.01 to 1.04 times. The excess compared to the control in the obtained dry mass varied by type and rates of fertilizers. Thus, in self-fertilization (var. 2, 3 and 4) was less and amounted to 63.00, 42.20 and 16.76%, in combined fertilization with $N_{80}K_{80}$ and $P_{80}K_{80}$ reached 82.66 and 68.21%, whereas combined fertilization with $N_{160}P_{80}K_{80}$

was the more - over a 143.93%. The other variants in combination with N_{160} occupied an intermediate position.

In the last year of study (1994) dry mass yields increased compared to those that were obtained in 1993 as follows: 1.20 times under control, by 1.04 to 1.06 times in self-fertilizing with nitrogen, phosphorus or potassium at a rate 80 kg.ha^{-1}, 1.02 to 1.03 times in combined fertilization with the same rates, while increasing the nitrogen alone, or combined with a comprehensive introduction phosphorus and/or potassium reached by 1.04 to 1.11 times. Nearly identical and maximum yields for the year were obtained by fertilization with $N_{160}P_{80}$ (4.57 t.ha^{-1}) and $N_{160}P_{80}K_{80}$ (4.50 t.ha^{-1}), as their excess in comparison with the unfertilized control reached 120.77 и 117.39%. Relatively small excess was in self-fertilizing with nitrogen, phosphorus or potassium in rates 80 kg.ha^{-1} (var. 2, 3 and 4) – respectively 42.99, 26.09 and only 1.93%, and in combined fertilization in the same rates (var. 5, 6 and 7) – respectively 81.64, 57.97 and 43.96%. The other variants of fertilization occupied an intermediate position in the dry mass productivity.

Average for the experimental period (1992-1994) nearly equal amounts of dry biomass were obtained after fertilization with $N_{160}P_{80}K_{80}$ and $N_{160}P_{80}$ – 4.38 and 4.30 t.ha^{-1}, this exceeded the unfertilized control respectively 128.12 and 124.48%. Significantly (by 109.37%) the dry matter yields were increased in complete mineral fertilization with $N_{80}P_{80}K_{80}$ (var. 8).

It is evident that nitrogen self-fertilizing increased the dry mass productivity of natural meadow *Agrostis capillarys - Festuca fallax* type, while the self phosphorus and potassium fertilization did not cause significant changes in the yield of dry matter. To a certain extent the effectiveness of potassium was increased in combination with N_{80} and significant in combination with N_{160}. On the productivity of dry matter combined phosphorous-potassium, nitrogen-potassium and nitrogen-phosphorous fertilizers increased the yields and the differences compared with unfertilized variant were well and very well demonstrated (++ ; +++). The complete mineral fertilization in rates of 80 and 160 kg.ha^{-1} nitrogen together with phosphorus and potassium increased productivity of grass stand in significantly higher compared with their self or combined use. The complete mineral fertilization with $N_{80}P_{80}K_{80}$ was less effective in terms of dry matter yield compared to fertilization with $N_{160}P_{80}$. This showed that increasing the rates of nitrogen had significantly greater effect on the addition of potassium in the lower nitrogen part in fertilizer combination. It is clear, that in combination with different mineral fertilizers potassium inhibited the effects of nitrogen and phosphorus part.

Chemical composition of the grass biomass The changes in the chemical content of forage biomass (Table 3) show that on average during the study compared with unfertilized control the crude protein content in dry matter increased in all fertilized variants. It is clear that the complete fertilization as a N_{80}, and with N_{160}, aroused the highest crude protein content – respectively 314 $g.kg^{-1}$ and 318 $g.kg^{-1}$. The combination of nitrogen and potassium also added to significant amounts of crude protein - 312 $g.kg^{-1}$ at fertilization with $N_{80}K_{80}$ and 314 $g.kg^{-1}$ at fertilization with $N_{160}K_{80.}$ Although the combination with nitrogen, phosphorus and potassium increased the nutritional value of dry matter, they did not cause a significant increase in the crude protein content. Regardless of the size of the fertilizer rate (80 or 160 $kg.ha^{-1}$), the lowest values of crude protein in dry matter were recorded in nitrogen self-fertilization – respectively 248 and 267 $g.kg^{-1}$, as well as phosphorus and potassium self-fertilization - 276 and 288 $g.kg^{-1}$.

The complete mineral fertilization with N_{80-160} lower in most fiber content in dry matter – corresponding to 249 and 256 $g.kg^{-1}$ and the unused of fertilizers (as it in control) and self-fertilization or in combinations with them increased reaching 280 $g.kg^{-1}$ (fertilization with $N_{80}P_{80}$) to 318 $g.kg^{-1}$ (fertilization with N_{80}) - 333 $g.kg^{-1}$ (control).

Table 3. Chemical composition of the grass biomass ($g.kg^{-1}$ DM) average for the 1992-1994 period.

Fertilization variants	Crude protein	Crude fiber	Crude fat	NFES	Crude ash
1. $N_0P_0K_0$ (Control)	185	333	50	369	63
2. N_{80}	248	318	51	341	42
3. P_{80}	276	290	53	348	33
4. K_{80}	288	294	53	345	20
5. $N_{80}P_{80}$	305	280	52	340	23
6. $N_{80}K_{80}$	312	261	52	340	35
7. $P_{80}K_{80}$	306	263	53	349	29
8. $N_{80}P_{80}K_{80}$	314	249	54	320	63
9. N_{160}	267	284	53	328	68
10. $N_{160}P_{80}$	312	270	54	310	36
11. $N_{160}K_{80}$	314	265	54	312	55
12. $N_{160}P_{80}K_{80}$	318	256	55	316	55

The same table shows that regardless of unused or fertilizer application, crude fat varied in relatively small limits, increasing from self-fertilization to the combined fertilization and from lower to higher rates of fertilizers. Thus, the least crude fat (50 $g.kg^{-1}$) were found in the dry matter of unfertilized control, of self-fertilization with nitrogen, phosphorus or potassium (var. 2-4) gradually increased to 51-53 $g.kg^{-1}$, the combined fertilization (var. 5-7) – 52-53 $g.kg^{-1}$, the combined fertilization with N_{160} (var. 10-11) – 54 $g.kg^{-1}$, and the complete mineral fertilization (var. 12) were the most - 55 $g.kg^{-1}$.

Regarding the content of nitrogen-free extract substances (NFES) opposite tendency was observed as the highest value (369 $g.kg^{-1}$) was reported in control. With the application of mineral fertilizers decreased values in self-fertilization (var.

2-4) - 341-348 $g.kg^{-1}$ and the combined fertilization (var. 5-7) - 340-349 $g.kg^{-1}$ to the complete fertilization (var. 12 and 8) - 316-320 $g.kg^{-1}$.

The crude ash content varied in relatively wide ranges, the maximum value reached during fertilization with N_{160}, the complete fertilization (var.8) as well as control – respectively 68, 63 and 63 $g.kg^{-1}$. At least crude ash in dry matter was in fertilization with K_{80}, $N_{80}P_{80}$ and $P_{80}K_{80}$ – 20, 23 and 29 $g.kg^{-1}$, and other variants occupied an intermediate position.

Conclusion

The experiment with a natural meadow of *Agrostis capillaris-Festuca fallax* type in Rhodope Mountains (Smolyan region, Southern Bulgaria) shows that according to fertilization variants there is a clear tendency towards earlier start of active vegetation and its next phenophases.

Most and almost equal amounts of dry biomass (4.38 and 4.31 $t.ha^{-1}$) were reported in fertilization with $N_{160}P_{80}K_{80}$ and $N_{160}P_{80}$, which exceeded the unfertilized control by 128.12 и 124.48%, respectively.

Compared with unfertilized variant, the crude protein content increased in all fertilizing variants, as in complete mineral fertilization with N_{80-160} accumulates the crudest protein - respectively 314 $g.kg^{-1}$ and 318 $g.kg^{-1}$.

As regards to other studying chemical indicators of the forage (crude fiber, crude fat, crude ash and nitrogen-free extract substances) the mineral fertilization also had an expressed positive effect.

Uticaj mineralnog dubrenja na neke biološke I proizvodne indikatore prirodnih livada tipa *Agrostis capillaris-festuca fallax* u rodopskim planinama (južna Bugarska)

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Rezime

Ogled na prirodnim livadama tipa *Agrostis capillaris - Festuca fallax* u rodopskim planinama (oblast Smoljan, južna Bugarska), prema varijantama đubrenja, pokazuje jasnu tendenciju ranije početka aktivne vegetacije i njenih kasnijih feno-faza.

Utvrđene su skoro identične količine biomase (4.38 and 4.31 $t.ha^{-1}$) u varijantama đubrenja sa $N_{160}P_{80}K_{80}$ i $N_{160}P_{80}$, sa vrednostima iznad kontrole bez đubrenja od 128,12 i 124,48%, respektivno.

U poređenju sa neđubrenom varijantom, sadržaj sirovog proteina se povećao u varijantama sa đubrenjem, jer se u slučaju potpunog N đubrenja sa N_{80-160} akumulira sirovih proteina – respektivno 314 gkg^{-1} i 318 gkg^{-1}.

U vezi sa ostalim ispitivanim hemijskim parametrima krmiva (sirova celuloza, pepeo i bezazotne materije), mineralno đubrenje je imalo pozitivan uticaj i na njih.

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