Available on-line at http://dse.usab-tm.ro
Banat's Journal of Biotechnology
2011, II(4),

# INFLUENCE OF MINERAL FERTILIZATION AND WAYS OF USE ON NATURAL MEADOW OF *AGROSTIS CAPILLARIS–FESTUCA FALLAX* TYPE IN THE RHODOPE MOUNTAINS (SOUTHERN BULGARIA)

**Yanko Kozhouharov[1], Vladimir Lingorski[2]**

[1]*Complex Experimental Station, 4700 Smolyan (Bulgaria)*
[2]*Research Institute of Mountain Stockbreeding and Agriculture, 5600 Troyan (Bulgaria),*
*E–mail: vilievl@yahoo.com*

***Abstract.*** The experiment showed that the application of mineral fertilization up to $N_{160}P_{80}$ increased dry matter yields between different ways of use as follows: from 5.88 to 6.45 t.ha$^{-1}$ (annually hay–pasture uses), from 4.72 to 5.21 t.ha$^{-1}$ (annually pasture–hay uses) and from 5.84 to 6.40 t.ha$^{-1}$ (1$^{st}$ year: pasture–hay uses; 2$^{nd}$ year: only pasture use; 3$^{rd}$ year: hay–pasture uses). As regards to studying chemical indicators of the forage (crude fiber, crude fat, crude ash and nitrogen–free extract substances) the mineral fertilization and alternation of ways of use had a positive effect. The introduction of mineral fertilizers at a rate up to $N_{160}P_{80}$ increased the obtained feed units and crude protein per 1 ha.

***Key words*:** natural meadow, mineral fertilization, ways of use, productive and chemical indicators, the Rhodope Mountains.

## Introduction

The natural meadows of *Agrostis capillaris–Festuca fallax* type in Smolyan region (the Middle Rhodope Mountains, Southern Bulgaria) represents 56.8% of the total area of natural meadows in the region, and annually give about 1.5–2.0 t.ha$^{-1}$ good quality hay (in 100 kg hay containing 46 food units and 3.41 kg digestible protein) [YAKIMOVA *et al.*, 1977; CHESHMEDJIEV, 1980].

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 multiple studies in Bulgaria [TOTEV, 1984, PAVLOV, 1996, TOTEV *et al.*, 1997, TOTEV *et al.*, 1998] and abroad [KASPER, 1971, SUR, 1975, SUNG *et al.*, 1985, GRANDI *et al.*, 1989, GIRALDEZ *et al.*, 1993, TENCHEV *et al.*, 1999] 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.

Together with mineral fertilization of the grass stand in farming practices are also important the ways of use (for hay, for pasture or combined), i.e. the phenophase for harvesting.

The purpose of this study was to establish the changes in productivity and chemical composition of forage biomass after combining of different ways of use and mineral fertilization on natural meadow of *Agrostis capillaris–Festuca fallax* type in the Rhodope Mountains (Smolyan region, Southern Bulgaria).

## Material and Methods

The field experiment was conducted during the 1993–1995 period, on natural meadow of *Agrostis capillaris–Festuca fallax* type in the Rhodope Mountains (Smolyan region, Southern Bulgaria) at 1100 m altitude.

The soil in the area of the 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 Smolyan region is characterized by mild winters, cool spring, not particularly hot summer and relatively hot autumn.

The precipitations are irregular and there are clearly marked a winter and spring–summer maximum. The rainfalls during April–June period are very important on the grasslands productivity. The reduced rainfall during July, August and September as well as light mechanical composition of soil had adverse effect on the grasslands productivity.

In conclusion, the Smolyan region has a specific soil and climatic conditions and that influence on the quantity and quality of forage mass of natural grasslands. The block–method was used in four repetitions and the harvesting plot area of 10 $m^2$ with the following fertilizer rates in kg per 1 ha as fertilization variants:

1. $N_0P_0$ (unfertilized variant)–as a control;
2. $N_{80}P_{80}$; 3. $N_{160}P_{80}$.

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 following ways of use by years and undergrowth's was used as variants:

1.Annually the 1st undergrowth–in hay–use, the 2nd undergrowth–in pasture–use (control);

2.Annually the 1st undergrowth–in pasture–use; the 2nd undergrowth–in hay–use;

3.In 1st year the 1st undergrowth–in pasture–use, the 2nd undergrowth–in hay–use; in 2nd year–the 1st, 2nd and 3rd undergrowths–in pasture–use; 3rd year: the 1st undergrowth–in hay–use, the 2nd undergrowth–in pasture–use.

The harvesting in pasture–use mode was accomplished in height of the grass stand 10–12cm.

The harvesting in hay–making mode was accomplished in flowering phenophase of grasses.

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

1. Dry mass (DM) yields (in $t.ha^{-1}$) was established by drying in muffle oven to constant weight at 105°C of 0.5 kg green mass samples, taken immediately after cutting each trial plot and repetition. It has been reported for years and average for the experimental period.
2. Chemical composition of the absolutely dry matter (in %)–of crude protein content, of crude fiber and of crude fat through infrared spectroscopy with apparatus InfraAlyser–400. The nitrogen–free extract substances (NFES) were calculated as the amount difference among crude protein, crude fiber, crude fat and crude ash.

## Results and Discussion

### Productive potential of dry mass.

The main factors as regards productive potential of the grass stand, as dry mass yields are the ways of use and applied mineral fertilization (*Table 1*).

It is obvious that in the 1st year (1994) the dry mass yields were almost the same in three variants of the study as ways of use. Thus, the obtained mass varied from 3.65 $t.ha^{-1}$ (var. 1 and 2) to 3.67 $t.ha^{-1}$ (var. 3). After application of mineral fertilizers ($N_{80}P_{80}$ and $N_{160}P_{80}$) it not only increased the dry matter yields but also work changes between the ways of use. The exceeding as regards $N_0P_0$ reached respectively 1.17 and 1.85 $t.ha^{-1}$, 0.41 and 1.00 $t.ha^{-1}$, 0.83 and 1.14 $t.ha^{-1}$.

It is obvious that var. 2 and 3 had almost identical dry matter yields because they had equivalent mode of use and fertilization.

The nitrogen doubling on $P_{80}$–background increased the dry mass–from 4.82 to 5.50 $t.ha^{-1}$ in var. 1 from 4.06 to 4.65 $t.ha^{-1}$ in var. 2 and from 4.50 to 4.81 $t.ha^{-1}$ in var. 3. Var. 1 had a higher yield from them because the influence of different way of use (hay–pasture use). In the second year of study (1995) when the investigated variants were put in three different ways of use where obtained differences in dry matter yields.

In unfertilized control the differences were not very large–from 4.15 $t.ha^{-1}$ (var. 2) to 4.48 $t.ha^{-1}$ (var. 3).

The $N_{80}P_{80}$–fertilization significantly increased these differences in yields and they reached from 5.12 $t.ha^{-1}$ (var. 2) to 6.33 $t.ha^{-1}$ (var. 3), i.e. respectively over with 0.97 and 1.85 $t.ha^{-1}$.

The application of $N_{160}P_{80}$–fertilization not only increased the yields but also determined the differences between them.

Thus, in control the dry mass yield reached 7.10 $t.ha^{-1}$ and in var. 2 and 3 respectively 5.56 and 6.72 $t.ha^{-1}$.

It is obvious that the early harvesting (in pasture–use) of the first undergrowth in variants 2 and 3 retained the influence of mineral fertilization to form higher yields.

Under the influence of ways of use in

Available on-line at http://dse.usab-tm.ro
Banat's Journal of Biotechnology
2011, II(4),

the last year of investigation (1996) were established differences in dry matter yields for var. 2 (from 4.39 to 5.44 t.ha$^{-1}$), and between var. 1 and 3–respectively from 4.10 to 6.77 t.ha$^{-1}$ and from 4.25 to 7.69 t.ha$^{-1}$.

The differences in yields between var. 1 and 2 were determined by the different uses of the grass stand.

On the other hand, in the same way of use the differences in yields between var. 1 and 3 were determined as a result of different ways to use var. 3 from the previous year.

The use of var. 3 in 1995 only for grazing was reflected in more favorable compared to the same annual usage.

The reason for that is because pasture–use in second year increased the reserve of nutrients in the root system of grasses and thus increased energy for growth and development of the grasses in the next year.

Average for the three years of study and three ways of use has no significant influence as regards quantity of yields, so the differences between them are immaterial.

The application of mineral fertilization with $N_{80}P_{80}$ and especially with $N_{160}P_{80}$ increased dry matter yields between different ways of use as follows: from 5.88 to 6.45 t.ha$^{-1}$ (in control), from 4.72 to 5.21 t.ha$^{-1}$ (in var. 2) and from 5.84 to 6.40 t.ha$^{-1}$ (in var. 3), i.e. more with 0.56 t.ha$^{-1}$.

**Table 1.**

Dry matter yields (t.ha$^{-1}$) in ways of use and fertilization level by years and average for the 1994–1996 period.

| Variant | Way of use | 1994 | | | 1995 | | | 1996 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ |
| Var. 1 (Control) Annually | 1st undergrowth –hay–use | 2.71 | 3.51 | 3.97 | 1.12 | 4.65 | 5.05 | 3.00 | 4.46 | 4.94 | 2.95 | 4.21 | 4.65 |
| | 2nd undergrowth–pasture–use | 0.94 | 1.31 | 1.53 | 1.16 | 1.99 | 2.05 | 1.10 | 1.71 | 1.83 | 1.07 | 1.67 | 1.80 |
| | Total for the variant | 3.65 | 4.82 | 5.50 | 4.28 | 6.64 | 7.10 | 4.10 | 6.17 | 6.77 | 4.02 | 5.88 | 6.45 |
| Var.2 Annually | 1st undergrowth – pasture–use | 1.12 | 1.45 | 1.69 | 1.28 | 1.81 | 2.00 | 1.31 | 1.78 | 1.98 | 1.24 | 1.68 | 1.89 |
| | 2nd undergrowth –hay–use | 2.53 | 2.61 | 2.96 | 2.87 | 3.31 | 3.56 | 2.98 | 3.21 | 3.46 | 2.79 | 3.04 | 3.32 |
| | Total for the variant | 3.65 | 4.06 | 4.65 | 4.15 | 5.12 | 5.56 | 4.39 | 4.99 | 5.44 | 4.03 | 4.72 | 5.21 |
| Var. 3 1st year | 1st undergrowth –pasture–use | 1.20 | 1.66 | 1.81 | | | | | | | | | |
| | 2nd undergrowth –hay–use | 2.47 | 2.84 | 3.00 | | | | | | | | | |
| | Total for the year | 3.67 | 4.50 | 4.81 | | | | | | | | | |
| 2nd year | 1st undergrowth –pasture–use | | | | 1.41 | 1.98 | 2.07 | | | | | | |
| | 2nd undergrowth –pasture–use | | | | 1.72 | 2.36 | 2.61 | | | | | | |
| | 3rd undergrowth –pasture–use | | | | 1.35 | 1.99 | 2.04 | | | | | | |
| | Total for the year | | | | 4.48 | 6.33 | 6.72 | | | | | | |
| 3rd year | 1st undergrowth – hay–use | | | | | | | 3.16 | 4.87 | 5.66 | | | |
| | 2nd undergrowth – pasture–use | | | | | | | 1.09 | 1.81 | 2.03 | | | |
| | Total for the year | | | | | | | 4.25 | 6.68 | 7.69 | | | |
| | Average for the variant | | | | | | | | | | 4.13 | 5.84 | 6.40 |
| | | | | | P at 5% | | | | 23.7 | 81.5 | 93.6 | | |
| | | | | | P at 1% | | | | 34.5 | 12 | 133.2 | | |
| | | | | | P at 0.1% | | | | 44.3 | 136.8 | 148.1 | | |

**Chemical composition of the grass biomass**

The chemical composition of grass biomass is influenced mainly by usage and the level of mineral fertilization (*Table 2*).

In unfertilized control the content of crude protein hardly changed between different uses–260 g.kg$^{-1}$ a dry matter in var. 1, 250 g.kg$^{-1}$ a dry matter in var. 2 and 269 g.kg$^{-1}$ a dry matter in var. 3.

After application of mineral fertilization increased both the total crude protein content, and differences between ways of use.

The content of crude protein was highest in fertilization $N_{80}P_{80}$ and rotation way of use (var. 3)–298 $g.kg^{-1}$ a dry matter and the lowest when using the first undergrowth was for grazing, a second for hay (var. 2)–275 $g.kg^{-1}$ a dry matter.

Applying $N_{160}P_{80}$–fertilization confirms this trend. Between content of crude protein and crude fiber was observed reverse dependency.

Crude fiber content decreased after the application and with increasing norms of mineral fertilization.

Crude fiber content was highest when it used the 1st undergrowth for grazing, and 2nd undergrowth for hay production–298 $g.kg^{-1}$ a dry matter in the control, 287 $g.kg^{-1}$ a dry matter in fertilization with $N_{80}P_{80}$ and 258 $g.kg^{-1}$ a dry matter in fertilization with $N_{160}P_{80}$.

**Table 2.**

Average chemical composition of the grass biomass in $g.kg^{-1}$ a dry matter for the 1994–1996 periods.

| Variant | Way of use | Crude protein | | | Crude fiber | | | Crude fat | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_{160}P_{80}$ |
| Var. 1 (Control) Annually | 1st undergrowth–hay–use | 236 | 255 | 288 | 245 | 220 | 214 | 52 | 54 | 55 |
| | 2nd undergrowth–pasture–use | 284 | 317 | 339 | 202 | 184 | 177 | 54 | 55 | 56 |
| | Average for the variant | 260 | 286 | 313 | 223 | 202 | 195 | 53 | 54 | 55 |
| Var.2 Annually | 1st undergrowth–pasture–use | 295 | 317 | 324 | 281 | 267 | 246 | 53 | 54 | 56 |
| | 2nd undergrowth–hay–use | 205 | 233 | 257 | 315 | 308 | 241 | 55 | 57 | 56 |
| | Average for the variant | 250 | 275 | 290 | 298 | 287 | 258 | 54 | 55 | 56 |
| Var. 3 1st year | 1st undergrowth–pasture–use | 308 | 320 | 329 | 260 | 254 | 249 | 52 | 53 | 55 |
| | 2nd undergrowth–hay–use | 218 | 242 | 277 | 321 | 310 | 302 | 54 | 54 | 55 |
| | Average for the year | 263 | 281 | 303 | 290 | 282 | 275 | 53 | 54 | 55 |
| 2nd year | 1st undergrowth–pasture–use | 291 | 341 | 357 | 201 | 197 | 190 | 53 | 54 | 56 |
| | 2nd undergrowth–pasture–use | 278 | 304 | 321 | 223 | 213 | 201 | 52 | 53 | 55 |
| | 3rd undergrowth–pasture–use | 251 | 290 | 310 | 235 | 220 | 208 | 54 | 55 | 56 |
| | Average for the year | 273 | 311 | 329 | 219 | 210 | 199 | 52 | 54 | 55 |
| 3rd year | 1st undergrowth–hay–use | 245 | 268 | 305 | 221 | 218 | 207 | 52 | 53 | 54 |
| | 2nd undergrowth–pasture–use | 297 | 336 | 351 | 193 | 186 | 180 | 53 | 54 | 55 |
| | Average for the year | 271 | 302 | 328 | 207 | 202 | 193 | 52 | 53 | 54 |
| | Average for the variant | 269 | 298 | 320 | 238 | 231 | 222 | 52 | 53 | 54 |

Crude fat content and NFES were not affected significantly by the impact of different ways of use.

In this connection, it was more marked the impact of mineral fertilization.

It was established that the fertilization increased the amount of crude fat in the forage and reduced the content of NFES.

Thus, in annually applied ways of use the average crude fat ranged from 53 $g.kg^{-1}$ a dry matter ($N_0P_0$) to 55 $g.kg^{-1}$ a dry matter ($N_{160}P_{80}$).

In annual changing uses the crude fat varied from 53 $g.kg^{-1}$ a dry matter ($N_0P_0$) to 55 $g.kg^{-1}$ a dry matter ($N_{160}P_{80}$) during the first year, from 52 $g.kg^{-1}$ a dry matter ($N_0P_0$) to 55 $g.kg^{-1}$ a dry matter ($N_{160}P_{80}$) during the second year and from 52 $g.kg^{-1}$ a dry matter

Available on-line at http://dse.usab-tm.ro
Banat's Journal of Biotechnology
2011, II(4),

($N_0P_0$) to 54 $g.kg^{-1}$ a dry matter ($N_{160}P_{80}$) during the third year.

And vice versa, for the NFES content in annual repeating ways of use were reported respectively from 328 to 312 $g.kg^{-1}$ a dry matter (var. 1) and from 332 to 313 $g.kg^{-1}$ a dry matter (var. 2).

In annual changing uses (var. 3) the NFES were average from 321 to 307 $g.kg^{-1}$ a dry matter (*Table 3*).

**Table 3.**

Average chemical composition of the grass biomass in $g.kg^{-1}$ a dry matter for the 1994–1996 period.

| Variant | Way of use | NFES | | | Crude ash | | |
|---|---|---|---|---|---|---|---|
| | | $N_0P_0$ | $N_{80}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ | $N_0P_0$ | $N_{80}P_{80}$ |
| Var. 1 (Control) Annually | 1st undergrowth–hay–use | 336 | 320 | 336 | 320 | 336 | 320 |
| | 2nd undergrowth–pasture–use | 320 | 318 | 320 | 318 | 320 | 318 |
| | Average for the variant | 328 | 319 | 328 | 319 | 328 | 319 |
| Var.2 Annually | 1st undergrowth–pasture–use | 320 | 310 | 320 | 310 | 320 | 310 |
| | 2nd undergrowth–hay–use | 345 | 331 | 345 | 331 | 345 | 331 |
| | Average for the variant | 332 | 320 | 332 | 320 | 332 | 320 |
| Var. 3 1st year | 1st undergrowth–pasture–use | 325 | 320 | 325 | 320 | 325 | 320 |
| | 2nd undergrowth–hay–use | 331 | 318 | 331 | 318 | 331 | 318 |
| | Average for the year | 328 | 319 | 328 | 319 | 328 | 319 |
| 2nd year | 1st undergrowth–pasture–use | 321 | 316 | 321 | 316 | 321 | 316 |
| | 2nd undergrowth–pasture–use | 318 | 311 | 318 | 311 | 318 | 311 |
| | 3rd undergrowth–pasture–use | 322 | 319 | 322 | 319 | 322 | 319 |
| | Average for the year | 320 | 315 | 320 | 315 | 320 | 315 |
| 3rd year | 1st undergrowth–hay–use | 318 | 310 | 318 | 310 | 318 | 310 |
| | 2nd undergrowth–pasture–use | 310 | 307 | 310 | 307 | 310 | 307 |
| | Average for the year | 314 | 308 | 314 | 308 | 314 | 308 |
| | Average for the variant | 321 | 314 | 321 | 314 | 321 | 314 |

In contrast to the aforementioned chemical indicators, the forage crude ash content was influenced by the ways of use and the mineral fertilization levels.

In harvesting of the grass stand in an earlier age (for grazing), the ash content was higher than in a later age (for hay production).

On the other hand, the mineral fertilization decreased in great measure the crude ash in the forage.

Thus, in annually applied ways of use the crude ash reached average 136 $g.kg^{-1}$ a dry matter (var. 1) and 66 $g.kg^{-1}$ a dry matter (var. 2) depending on hay or pasture was used the 1st undergrowth.

After $N_{160}P_{80}$–fertilization the crude ash content reached respectively 243 and 83 $g.kg^{-1}$ a dry matter.

In annual repeating ways of use were established similar trends in the different years of study.

Thus, in the 1st year the crude ash decreased from 66$g.kg^{-1}$ a dry matter ($N_0P_0$) to 58$g.kg^{-1}$ a dry matter ($N_{160}P_{80}$).

In the 2nd year the decrease was respectively from 136 to 108$g.kg^{-1}$ a dry matter and in the 3rd year–from 155 to 122$g.kg^{-1}$ a dry matter (average for the variant from 119 to 96$g.kg^{-1}$ a dry matter).

**Productive potential of feed units and crude protein**

The application of the different ways

of use of the grass stand as well as mineral fertilization influenced on received feed units (FU) and crude protein (*Table 4*).

In non–fertilization the feed units were almost the same for the different ways of use: 258.7 FU.ha$^{-1}$ for var. 1, 266.3 FU.ha$^{-1}$ for var. 2 and 276.1 FU.ha$^{-1}$ for var. 3.

The introduction of mineral fertilizers at a rate $N_{80}P_{80}$ especially with $N_{160}P_{80}$ increased the obtained feed units per 1 ha and caused differences between uses.

Thus, the after fertilization with $N_{160}P_{80}$ were reported 460.8 FU.ha$^{-1}$ for control, 387.1 FU.ha$^{-1}$ for var. 2 and 469.0 FU.ha$^{-1}$ for var. 3.

From the same table it is seen that in non–fertilization variant there are no significant differences between uses, as their crude protein yields were nearly identical.

**Table 4.**

Average feed units (FU.ha$^{-1}$) and crude protein yields (t.ha$^{-1}$) for the 1994–1996 periods.

| Variant | Way of use | $N_0P_0$ | | $N_{80}P_{80}$ | | $N_{160}P_{80}$ | |
|---|---|---|---|---|---|---|---|
| | | FU.ha$^{-1}$ | Crude protein, t.ha$^{-1}$ | FU.ha$^{-1}$ | Crude protein, t.ha$^{-1}$ | FU.ha$^{-1}$ | Crude protein, t.ha$^{-1}$ |
| Var. 1 (Control) Annually | 1$^{st}$undergrowth – hay–use | 203.3 | 69.5 | 302.9 | 107.2 | 349.0 | 134.0 |
| | 2$^{nd}$ undergrowth – pasture–use | 55.4 | 30.3 | 99.9 | 52.8 | 111.8 | 61.1 |
| | Total for the variant | 258.7 | 99.8 | 402.8 | 160.0 | 460.8 | 195.1 |
| Var.2 Annually | 1$^{st}$undergrowth – pasture–use | 79.2 | 36.5 | 109.3 | 53.3 | 137.8 | 61.1 |
| | 2$^{nd}$ undergrowth – hay–use | 187.1 | 57.2 | 216.1 | 70.9 | 249.3 | 85.4 |
| | Total for the variant | 266.3 | 93.7 | 325.4 | 124.2 | 387.1 | 146.5 |
| Var. 3 1$^{st}$ year | 1$^{st}$undergrowth – pasture–use | 77.0 | 37.0 | 112.7 | 53.0 | 128.3 | 59.4 |
| | 2$^{nd}$ undergrowth – hay–use | 162.7 | 53.7 | 204.6 | 68.2 | 228.2 | 83.1 |
| | Total for the year | 239.7 | 90.7 | 317.7 | 128.8 | 356.5 | 142.5 |
| 2$^{nd}$ year | 1$^{st}$undergrowth – pasture–use | 84.8 | 41.4 | 124.4 | 67.3 | 138.5 | 73.8 |
| | 2$^{nd}$ undergrowth – pasture–use | 117.0 | 47.8 | 164.9 | 71.6 | 195.5 | 83.6 |
| | 3$^{rd}$ undergrowth – pasture–use | 72.7 | 33.8 | 115.5 | 57.7 | 122.2 | 63.2 |
| | Total for the year | 274.5 | 123.0 | 404.8 | 196.6 | 456.2 | 220.6 |
| 3$^{rd}$ year | 1$^{st}$undergrowth – hay–use | 244.3 | 77.4 | 375.2 | 130.5 | 452.4 | 172.5 |
| | 2$^{nd}$ undergrowth – pasture–use | 70.6 | 32.3 | 119.7 | 61.0 | 141.8 | 71.1 |
| | Total for the year | 314.0 | 109.7 | 494.9 | 191.5 | 594.2 | 243.6 |
| | Average for the variant | 276.1 | 107.8 | 405.8 | 172.3 | 469.0 | 202.2 |

The yield values varied from 93.7t.ha$^{-1}$ (var.2) to 107.8 t.ha$^{-1}$ (var. 3).

The mineral fertilization with a rate up to $N_{160}P_{80}$ caused significant differences between the separate uses.

Thus, the crude protein yield after $N_{160}P_{80}$–fertilization reached 195.1 t.ha$^{-1}$ (var. 1), in var. 2–146.5 t.ha$^{-1}$ (var. 2) and in var. 3–202.2 t.ha$^{-1}$.

## Conclusions

The experiment in Rhodope Mountains (Southern Bulgaria) shows that the mineral fertilization and ways of use of natural meadow of *Agrostis capillaris–Festuca fallax* type had a positive effect on forage productive and chemical indicators.

The application of mineral fertilization up to $N_{160}P_{80}$ increased dry matter yields between different ways of use as follows: from 5.88 to 6.45 t.ha$^{-1}$ (annually hay–pasture use), from 4.72 to 5.21 t.ha$^{-1}$ (annually pasture–hay use) and from 5.84 to 6.40 t.ha$^{-1}$ (1$^{st}$ year: pasture–hay use; 2$^{nd}$ year:

only pasture use; 3rd year: hay–pasture use).

As regards to studying chemical indicators of the forage (crude fiber, crude fat, crude ash and nitrogen–free extract substances) the mineral fertilization and alternation of ways of use had a positive effect.

The introduction of mineral fertilizers at a rate up to $N_{160}P_{80}$ increased the obtained feed units and crude protein per 1 ha.

### References

1. Cheshmedjiev, B. **1980.** Feed characteristics of the natural pastures and meadows in Bulgaria. Zemizdat, Sofia.
2. Giraldez, F., J. Alvares, F. Martines, S. Solis. **1993.** Ruminal degradation of hay from permanent pastures. Effect of stage of maturity, *Archives de Zootechnica*, 42, 156: 13–20.
3. Grandi, A., M. Cagiotti, F. Blassi. **1989.** Investigation of flora productivity and nutritive value of meadow pasture in Ragnolo Macerata. *Zootechnica e Nutrizione Animale*, 15, 2: 115–133.
4. Kasper, J. **1971.** Prosperok k studinzmien v chemickom zloteny docasnych travnicu parastov pri razdielny dusteatej vyzive. *Redecke Prace*, VULP Banska Bistrica, 6, 111–137.
5. Pavlov, D. **1996.** Productivity, nutritive value, qualitative characteristics of different groups forage plants and possibilities for their prediction. *Dissertation on PhD of Agricultural Sciences*, Stara Zagora.
6. Sung, K., C. Kim. **1985.** Effect of intake on digestibility of grass hay harvested at different cutting dates, *Journal of the Korean Society of Grassland Science*, 5, 2: 111–115.
7. Sur, D. **1977**. Vpliv vizivy a viuzivania na dinamiku narastania hmoty na prirodzenom travnom parasite. *Redecke Prace*, VULP Banska Bistrica, 9, 49.
8. Tenchev D., K. Stoeva, Kh. Yancheva. **1999.** Study on the fertilization of natural pastures of *Cynodon dactylon–Lolium perenne* type in the Strandja region. *Journal of Mountain Agriculture on the Balkans*, vol. 2, 4: 413–419.
9. Totev, T. **1984.** Investigations on the regeneration and utilization of natural meadows and pastures in the upland mountainous and alpine regions of central part of the Balkan range. *Dissertation on PhD of Agricultural Sciences*, Troyan.
10. Totev T., Tz. Mihovsky, V. Lingorski, K. Tankov, D. Pavlov. **1997.** The effect of mineral fertilisation on the variation in the nitrate concentration of fodder from natural and artificial grass–stands, *Biotehnologija u stocarstvu*, vol. 13, No3–4: 245–252.
11. Totev, T., V. Lingorski, K. Tankov, Ts. Mihovski, B. Chourkova, D. Karadocheva, K. Belperchinov, D. Pavlov. **1998.** Variation of forage productivity and nitrate content under the influence of fertilizer application on mountain meadows, *Journal of Mountain Agriculture on the Balkans*, vol. 1, 5: 366–373.
12. Yakimova, Ya., M. Ouzunov, N. Petrovski, I. Popov, M. Mitev. **1977.** Improvement and utilization of natural meadows and pastures. Zemizdat, Sofia.

Received: August 7, 2011
Accepted: October 30, 2011