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Impact of Mineral and Organic Foliar Fertilizing on Some Productivity Factors of a Natural Grassland of Chrysopogon gryllus L. Type and a Natural Pasture of Nardus stricta L.

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Abstract. During the period 2011-2013, the impact of some factors on the productivity of natural grassland under the conditions of mineral and organic foliar fertilization was studied in the Central Balkan Mountain region. The summarized multifactor analysis shows that in the Central Balkan Mountains, the productivity of natural grasslands (a meadow of *Chrysopogon gryllus* L. type and a pasture of *Nardus stricta* L. type) was influenced by the type of grassland (63.42%) at first place, followed by the agroecological conditions during the year (20.32%) and the fertilizing method (mineral with N and P or foliar with Biostim) - 8.82%. The level of fertilization (7.43%) had the least effect on the yield of the studied grassland. The data obtained through the summarized RSM analysis indicated a slightly higher efficiency of foliar fertilizing than the variable mineral fertilization for both types of grassland. A relatively high regressional dependence between productivity and moisture supply of the natural grass biomass has been established, which allows for an approximate prediction of the yields of natural grasslands with applied mineral and foliar fertilizing. The coefficients of determination (R = 0.7-0.8) were high enough for practical determination of productivity, by the precipitation amount during the critical months for Bulgaria (April - July). When using the annual or seasonal precipitation amount, the accuracy is less.

Key words: *Chrysopogon gryllus* L., *Nardus stricta* L., mineral fertilization, organic foliar fertilizing.

Introduction

The natural grasslands in Bulgaria occupy a considerable part of the mountain and hilly ranges of the Central Balkan Mountains, therefore they have a great economic significance. The botanical composition and dynamics of grassland community development are related to environmental conditions and affect the actual productivity of the forage mass formed (Naydenova et al., 2015). The proper use of technology combined with the implementation of appropriate measures (resowing, irrigation, nourishing, etc.) reduce the percentage of low-productive and harmful species, respectively improve the quality and nutritional value of the grass cover.

Mineral fertilization with N and P is an effective measure. It favors the floristic composition (Jankowska-Huflejt, 2012; Koukoura et al., 2005; Popescu and Churkova, 2015), increases the productivity and concentration of crude protein in natural grasslands (Budakli et al., 2012; Maruşca et al., 2014; Min et al., 2002; Vintu et al., 2015). The annual fertilization of natural meadow of *Chrysopogon gryllus* L., with the combination - N_6P_6 leads to a proven increase in the amount of crude protein (100.42 g kg^{-1}), crude fat (22.01 g kg^{-1}), minerals (78.10 g kg^{-1}) and phosphorus (3.37 g kg^{-1}) in dry matter. The values exceed the nontreated control by 52.3% (CP), 31.1% (CF), 3.1% (Ash) and 81.2% (P), respectively (Iliev et al., 2019).

The treatment of natural grasslands with foliar organic fertilizers, which include humic and fulvoacid acids, combined with basic macro and microelements, stimulate root system growth and increase the nutrient intake (including more inaccessible phosphorus) by plants species (Abdullah, 2010; Datta et al., 2011; Sengalevich, 2007). The application of humate fertilizers increases the protein fraction and improves the nutritional value of feed (Klimas et al., 2010). Foliar fertilizing with the organic fertilizer Biostim affects the botanical composition and increases the dry matter productivity of the natural grassland with dominant species of *Chrysopogon gryllus* L., and *Nardus stricta* L., (Iliev et al., 2017; Iliev, 2018).

The agrotechnical events improve the yield and quality of the forage mass, respectively the physiological condition and productivity of livestock.

The purpose of the present study was to investigate the impact of some factors on the productivity of natural meadows and pastures, at different fertilization levels with N and P and the organic foliar fertilizer Biostim.

Material and Methods

The study was conducted in 2011-2013 at the Research Institute of Mountain Stockbreeding and Agriculture - Troyan, on:

- a natural meadow of *Chrysopogon gryllus* L. type, located in Makaravets locality at an altitude of 460 m.

- a natural pasture of *Nardus stricta* L. type, located in Chuchul locality at an altitude of 1400 m.

The impact of mineral and organic fertilization on the productivity of natural herbs has been studied.

Combinations of alternative nitrogen and phosphorus fertilizing were investigated in the following variants of mineral fertilizing: 1. Nontreated (K_1); 2. Annual fertilizer application kg/ha: $N_{60}P_{60}$ (K_2); 3. First fertilizing year with N_{60} (N_{60}/I); Second and third fertilizing year with P_{60} (P_{60}/II and P_{60}/III); 4. First and second year fertilizing year with P_{60} (N_{60}/I; second and third fertilizn year with N_{60} (N_{60}/II and N_{60}/III); 5. First and second year fertilization with N_{60} (N_{60}/I and N_{60}/II); Third year fertilization with P_{60} (P_{60}/III); 6. First and second fertilizing year with P_{60} (P_{60}/I and P_{60}/II); Third year fertilization with N_{60} (N_{60}/III); 7. First fertilizing year with N_{60} (N_{60}/I); Second fertilizng year with P_{60} (P_{60}/II); Third fertiling year with N_{60} (N_{60}/III); 8. First fertilizng year with P_{60} (P_{60}/I); Second fertiling year N_{60} (N_{60}/II); Third fertiling year with P_{60} (P_{60}/III).

Foliar feeding with organic fertilizer was applied once a year, and the working solution was introduced with a backpack sprayer during active grass vegetation. The reaction, salt concentration and composition of foliar fertilizer Biostim were as follows: reaction (pH) - 6.8, salt concentration 20.15, nitrogen (N) - 2.1%, phosphorus (P) - 1.54%, potassium (K) - 11.2%, calcium (Ca) - 0.15%, magnesium (Mg) - 0.01%, iron (Fe) - 0.024%, zinc (Zn) - 0.037%. Organic content - 2.25, humic acids - up to 14%, fulvic acids up to 7%.

The variants of the experiment were: 1. Nontreated (Control); 2. Foliar application with Biostim 1000 ml/ha; 3. Foliar application with Biostim 2000 ml/ha; 4. Foliar application with Biostim 3000 ml/ha; 5. Foliar application with Biostim 4000 ml/ ha.

The harvesting of the test areas is carried out during the shedding prior to flowering of the seedling. The production of aboveground biomass was determined by mowing as follows: in the meadow of *Chrysopogon gryllus* L. type in the period from tasseling to the beginning of flowering period of the dominant species, and in the pasture of *Nardus stricta* L. type until the matgrass reached ear formation phase.

The territory of experiment occupies the southernmost parts of the Pre-Balkans (Lovech Mountain) in humid continental climate subregion (Sabev & Stanev, 1963). The ridges are sharp, and the slopes steep and represent a natural barrier to the main atmospheric circulation in the area. The climate is characterized by great diversity due to the physical and geographical conditions of the Troyan region assigned to the Balkan Mountain region, including the Balkan Mountain and the Pre-Balkans (Georgiev, 1979). Warm and dry winds (from the south and southwestern air currents) are common in spring and autumn, which greatly reduces air humidity and temperatures have a continental influence. The average annual temperature (10-11°C) is characterized by territorial differentiation from north to south and an increase in altitude (Ninov, 1997). Precipitation is unevenly distributed with maximum in summer (309 mm) and minimum (168 mm) in winter. In the spring and autumn the precipitation recorded is 242 mm and 209 mm, respectively. Annual precipitation amount in the Pre-Balkans ranges from 567 to 1200 mm.

For a more complete description of the area, data are presented from a weather station in Troyan, located at an altitude of 384 m (Tables 1 and 2). Temperature is an important element of climate that characterizes the climatic type of a particular area. Its spatial and temporal distribution influences plant metabolism - photosynthesis, respiration and transpiration. Forage grasses have different requirements for heat, which determines their range and their sustainability. Cheshmedzhiev (1980) reports that high temperatures during summer not only reduce the yield of natural grasslands, but impair the feed quality due to the increase in fiber and decrease in the weight ratio of leaves to the stem. The steady retention of the average air temperature above 4°C, which begins the vegetation period of the pastures, is around March 20th, with the end of the vegetation for the year around November 20th, i.e. the average duration of the vegetation season is about 245 days. The temperature in the vegetation season (April-September) for the experimental period (2011-2013) was higher than the average in the region, registered for 25 years ahead (16.8°C) by an average of 1°C. It was almost 2°C in the second year.

Meteorological conditions during the study show variation in temperature and precipitation, which specifically affects the development and productivity of grass species.

This variation can be seen both in the different years of the study and when compared with the multiannual averages (climate norms) for the period 1988-2013.

The soil on which the experiments are based is light gray, forest, with shallow - A horizon and deep, heavily charred - B horizon. The experiment was set on a slope with an inclination of 7° (near a forest), southeastern exposure, using the block method in 4 replications, with a plot size of 5 m^2.

The results were statistically processed by ANOVA 10. LSD test was conducted for statistical significance of differences, standard deviation and coefficient of variation, as well as using variational-statistical method (Lidanski, 1988). RSM- Responsible Surface Method - summary profile of variable characteristics (productivity of grassland type, fertilizing method, years).

Results and Discussion

Regressional dependences between the dry matter yield from a meadow of Chrysopogon gryllus L. *type and the amount of precipitation in mineral and organic foliar fertilization.*

In the case of variable fertilization of a grassland of *Chrysopogon gryllus* L. type with mineral nitrogen and phosphorus, the highest yield of biomass was obtained in the variants N_{60} kg/ha (first year), P_{60} kg/ha (second year) and N_{60} kg/ha (third year). The highest biomass amount was registered in foliar fertilizing with Biostim at a dose of 3000 ml/ha.

In the third experimental year, mineral fertilization registered the highest effect on the productivity of a meadow of *Chrysopogon gryllus* L. type. The amount of dry matter in the mineral fertilization variants was from 24.47 to 66.49% ($P < 1.0$ and $P < 0.1$) higher than the nontreated control.

According to the correlation analysis, the dry matter yield correlates very well with the amount of precipitation. On this basis, regression equations have been developed to estimate the yield by precipitation as an independent variable. Dry matter yield can be precisely determined by using a second degree polynomial. The coefficient of determination expressing the relationship between dry matter yield and precipitation during the vegetation (monthly) $R = 0.734$ is sufficiently high (Table 3). The standard error in the estimate ranges from 0.93 to 8.05.

The error is smallest when precipitation is used as an independent variable in August. The accuracy of the equations is higher when they include precipitation in the months of April, June, July and August, and less when is used the sum of precipitation during the vegetation season (April - September). The least accurate equations are obtained using the annual precipitation sum as an independent variable.

The average precipitation increased by 79.3 mm in the third experimental year only (2013) during the vegetation season (April-September) compared to a long period (476.5 mm). A deficit of 64.5 mm was reported in 2011 and a deficit of 137.6 mm in 2012 (Table 2). Drought has adversely affected the complex biochemical processes of plant growth and development.

Particularly significant were the precipitation data in 2012, when the drought during the summer months was extreme. During the vegetation season (April-September), the registered precipitation of 338.9 mm was 137.6 mm (28.88%) less than for a 25-year period (476.5 mm). In 2013, the amount of vegetation precipitation (555.8 mm) was 79.3 mm (16.64%) more than the long-term period (476.5 mm).

Foliar fertilizing with Biostim during the first year did not significantly affect the dry matter yield as the probable cause was the specific interaction: foliar fertilizer - type of grassland - climatic conditions. In the second and third years, the excess over control was 102.1-122.9% (at 3000 ml/ha).

The relationship between dry matter yield (obtained by *Chrysopogon gryllus* L. meadow type during foliar fertilizing) and precipitation is relatively good and is proven by a high determination coefficient $R = 0.801$ (Table 4). There is a high dependence between the yield and precipitation in April, June, July and August, where the average error is smaller. The reliability of equations is statistically significant at $P < 0.00207$. The accuracy is less when precipitation is used in the equations in May, as well as the precipitation amount during the vegetation period or the annual precipitation amount.

Table 1. Air temperature (°C).

Month / Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I –XII	IV-IX
2011	-0.2	-0.3	4.9	9.7	14.7	18.5	21.0	20.2	18.2	8.8	1.8	2.6	9.99	17.1
2012	-2.1	-5.4	5.6	12.2	15.1	20.8	24.2	21.7	17.8	13.2	7.6	-0.4	10.86	18.6
2013	1.1	3.8	5.4	12.0	17.5	18.7	19.4	22.7	15.4	12.1	7.7	0.8	11.38	17.6
Average 2011-2013	-0.4	-0.6	5.3	11.3	15.8	19.3	21.5	21.5	17.1	11.4	5.7	1.0	10.74	17.8
Average 1988-2013	-0.6	2.1	5.4	10.3	15.2	18.6	20.8	20.5	15.6	10.8	5.7	1.8	10.52	16.8

Table 2. Monthly and annual precipitation (mm).

Month / Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I –XII	IV-IX
2011	22.5	24.8	41.7	68.0	69.1	98.4	72.9	96.8	6.8	109.0	2.0	34.3	646.3	412.0
2012	124.5	45.6	35.5	36.0	174.0	51.8	7.2	39.1	30.8	43.6	11.8	79.1	679.0	338.9
2013	43.3	62.6	49.7	92.1	90.3	274.6	61.2	14.9	22.7	53.2	27.7	15.0	807.3	555.8
Average 2011-2013	63.4	44.3	42.3	65.4	111.1	141.6	47.1	50.3	20.1	68.6	13.8	42.8	710.9	435.6
Average 1988-2013	37.5	39.1	56.2	61.7	93.0	104.3	83.5	69.7	64.1	51.8	40.4	44.8	734.2	476.5

Table 3. Regressional equations of the dependence between dry matter yield and precipitation in a meadow of *Chrysopogon gryllus* L. type, using mineral fertilizing with N and P. Legend: Determination coefficient (R); Standard Estimation Error (*SEE); Dependent and Independent Dimensions (F); Statistical significance of the equation (P<).

Equation	R	SEE*	F	P<
Y = 200900.5-543.5W I-XII+0.4W I-XII2	0.734	8.05	12.26	0.00029
Y = -26707.2+134.8W IV- IX-0.1W IV-IX2	0.734	2.48	12.26	0.00029
Y = -4337.6+243.14W IV-1.81W IV2	0.734	1.23	12.26	0.00029
Y = 10076.55-119.2W V+0.42W V2	0.734	2.11	12.26	0.00029
Y = -909.077+67.9W VI-0.199W VI2	0.734	1.32	12.26	0.00029
Y = 2537.4-73.07W VII+1.25W VII2	0.734	1.17	12.26	0.00029
Y = 3570.7-66.08W VIII+0.712W VIII2	0.734	0.93	12.26	0.00029

Table 4. Regression equations for the dependence of dry matter yield - precipitation, from a meadow of *Chrysopogon gryllus* L. type with foliar fertilizing with Biostim. Legend: Determination coefficient (R); Standard Estimation Error (*SEE); Dependent and Independent Relation (F); Statistical significance of the equation (P<).

Equation	R	SEE*	F	P<
Y = 18376.74-485.2W I-XII+0.3W I-XII2	0.801	9.37	10.8	0.00207
Y = -30295.1+163.4W IV-IX-0.2W IV-IX2	0.801	2.89	10.8	0.00207
Y = -4611.46+330.79W IV-2.64W IV2	0.801	1.39	10.8	0.00207
Y = 19334.46-269.08W V+1.04W V2	0.801	2.46	10.8	0.00207
Y = 694.98+73.39W VI-0.23W VI2	0.801	1.53	10.8	0.00207
Y = 5244.1-211.04W VII+2.97W VII2	0.801	1.36	10.8	0.00207
Y = 3347.06+6.44W VIII+0.183W VIII2	0.801	1.08	10.8	0.00207

The precipitation regime of the region is continental. Most precipitation falls in summer (309 mm) and spring (242 mm), less in autumn (209 mm) and at least in winter - 168 mm (Ninov, 1997). Precipitation amount in months with temperatures higher than 0°C ranges from 596 to 600 mm.

The agroecological conditions of the experimental area, as well as the applied agrotechnical events, have a significant impact on the productivity and development of natural grassland communities.

The efficiency in supplying plants with the optimal amount of soil moisture is determined by: the depth of the root system and the weight of its total mass; the length of life of roots, their total length and surface; season, phase of development and mode of plant use.

Droughts are observed in all seasons of the year, which influences the physiological processes during the different phenophases and stages of the individual development of crops. Under these conditions, natural grasslands manage to form one harvest and very rarely autumn hay (aftergrass).

The moisture content and precipitation distribution during the vegetation season affect productivity and determine to a varying degree the effects of testing other factors, such as fertilizing method (mineral or foliar) and specific morphological structure, and species potential (a meadow of *Chrysopogon gryllus* L. type and a natural pasture of *Nardus stricta* L. type) of the grasslands.

Factor analysis of the impact of fertilizing and climatic conditions during the year on the productivity of a meadow of Chrysopogon gryllus L. *and natural pasture of Nardus stricta* L. *grassland.*

The type of grassland and the conditions of the year have a greater impact (η^2 = 0.55-0.56%) on the productivity of the studied grasslands after applied fertilization (N and P) compared to the fertilizer level factor. The difference in the strength of the influence of the two factors on the studied trait is insignificant, respectively, 21.89% and 22.70% (Table 5). The strength of their combined action (21.81%) is equal to the independent influence of the type of grassland. The private determination coefficient (η^2) confirms the power of influence of these factors.

The level of fertilization has a weaker effect (7.59%) on the yield of the natural grassland of *Chrysopogon gryllus* L. type and a pasture with *Nardus stricta* L.

For the experimental period, fertilizing with P_{60} (first year), N_{60} (second year) and P_{60} (third year) recorded the lowest values regarding the productivity of grassland. In contrast, the introduction of: P_{60} (first and second year) + N_{60} (third year) and N_{60} (first year) + P_{60} (second year) + N_{60} (third year) increased optimally (2316.0 kg/ha) the yield of the biomass.

In the variants with bio-fertilization, yields in the first and second experimental years were almost identical. In the third vegetation season, the productivity of natural biomass was significantly higher (3062.7 kg/ha), mainly in the variants with foliar fertilizing with 4000 ml/ha Biostim.

A significant difference was observed in the strength of the factorial influence in both types of grassland treated with humic fertilizer Biostim. The type of grassland had the main and strongest impact (62.81%) followed by the combination of type x year (14.04%) - Table 6. The level of fertilization had the slightest impact (2.45%) on the aboveground mass production both with the mineral fertilization and the foliar bio-fertilization.

The RSM Combined profile clearly shows that, after the application of nitrogen and phosphorus mineral fertilization, the grassland of *Chrysopogon gryllus* L. type has significantly higher productivity than that of the pasture of *Nardus stricta* L. type (Fig. 1).

The year has a much slighter impact here - only 7.84%. Fertilization has a very low impact - only 2.45%.

The interaction type in relation to year - 14.04% is higher than the year as a separate factor - 7.84%.

The RSM combined foliar fertilization profile shows that the meadow yields are higher than the pasture (Fig. 2).

The four factors tested have different effects on the productivity of both natural grasslands: a meadow of *Chrysopogon gryllus* L. and a pasture of *Nardus stricta* L. type.

The multifactor analysis of the impact of the factors, performed on 312 results from the four attempts in four replications, shows that for the conditions of the Central Balkan Mountain the productivity of the grasslands is most strongly influenced by the type of the grassland - 63.42% at the highest private determination coefficient η^2 = 0.35% (Table 7).

The year with its specific climatic conditions - rainfall - 20.32%, is in second place in terms of impact.

In third place is the fertilizing method - mineral with N and P or foliar fertilizing with Biostim - 8.82%.

The fourth place in terms of the impact is for the level of fertilization (applied doses of fertilizers and the way of their alternation) - 7.43%.

The RSM method for summarizing the variation of individual factors shows that the productivity of a meadow of *Chrysopogon gryllus* L. type on average is significantly higher than that of a pasture of *Nardus stricta* L. type (Fig. 3).

Two types of fertilization were tested - mineral with alternate application of N and P fertilizers and foliar fertilizing with organic fertilizer. Higher yields were obtained from foliar fertilizing.

The lowest yields were obtained for both types of weeds and fertilizers in 2012. In the first and third years, yields were almost identical. This is explained by the unfavorable climatic conditions this year, especially during the vegetation season.

From the first to the fifth variant of fertilization, yields increased and then decreased.

Table 5. Degree of the impact of factors in mineral fertilization with N and P. Legend: Degree of Freedom (df); Relationship between analyzed quantities (F); Reliability of the difference between indicators (P<); Partial eta-squared (η^2).

Factors	SS	df	F	P<	η^2(%)	Degree of impact (%)
Grassland type (meadow or pasture)	63241461.5	1	176.701	0.000000	0.55	21.89
Year	65586200.8	2	91.626	0.000000	0.56	22.70
Level of fertilizing	21920207.2	7	8.750	0.000000	0.30	7.59
Type*Year	63020976.6	2	88.043	0.000000	0.55	21.81
Type*Fertilizing	27508610.3	7	10.980	0.000000	0.35	9.52
Year*Fertilizing	21951145.1	14	4.381	0.000002	0.30	7.60
Type*Year*Fertilizing	25679106.1	14	5.125	0.000000	0.33	8.89
Mistakes	51537725.6	144				

Table 6. Degree of factor impacts on foliar fertilizing with Biostim. Legend: Degree of Freedom (df); Relationship between analyzed quantities (F); Reliability of the difference between indicators (P<); Partial eta-squared (η^2).

Factors	SS	df	F	P<	η^2(%)	Degree of impact (%)
Type of grassland meadow or pasture	185867120.6	1	246.87	0.000000	0.73	62.81
Year	23211291.0	2	15.414	0.000002	0.26	7.84
Level of fertilizing	7245288.5	4	2.406	0.055310	0.10	2.45
Type*Year	41534890.8	2	27.583	0.000000	0.38	14.04
Type*Fertilizing	10769864.5	4	3.576	0.009395	0.14	3.64
Year*Fertilizing	16470303.7	8	2.734	0.009545	0.20	5.57
Type*Year* Fertilizing	10827459.5	8	1.798	0.087779	0.14	3.66
Mistakes	67761628.1	90				

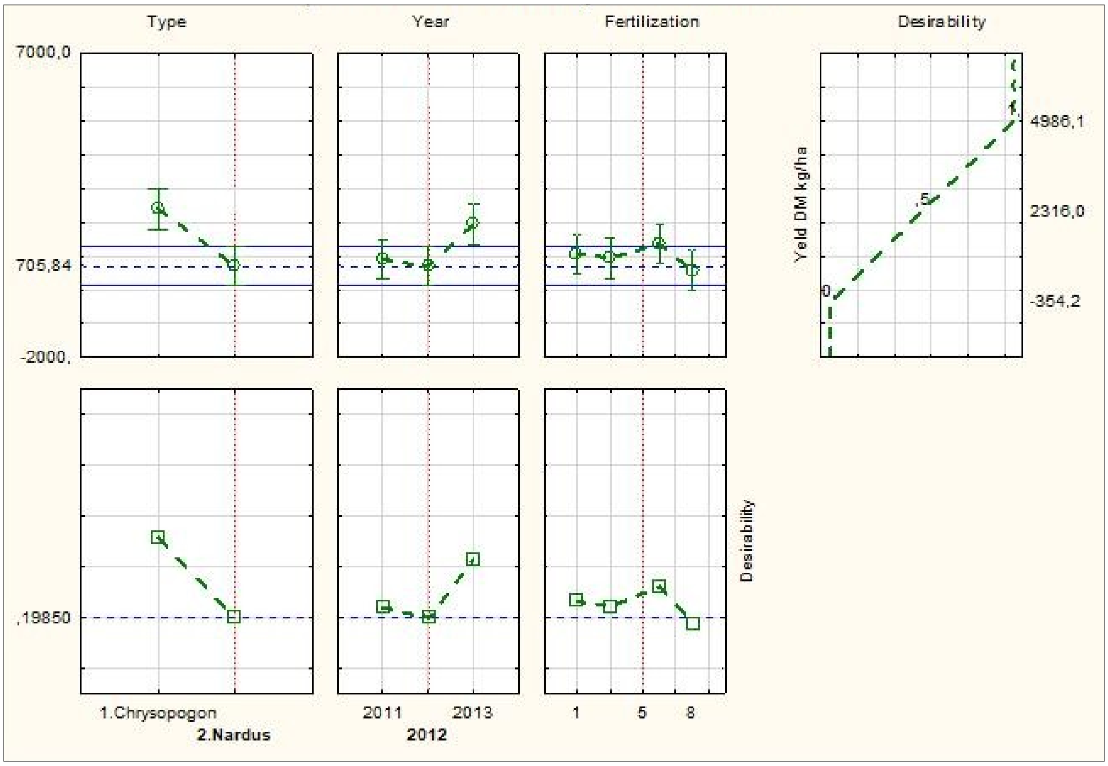

Fig. 1. RSM profiles for predicted values and desirability of factors in meadow *Chrysopogon* and pasture *Nardus* fertilized by mineral fertilization.

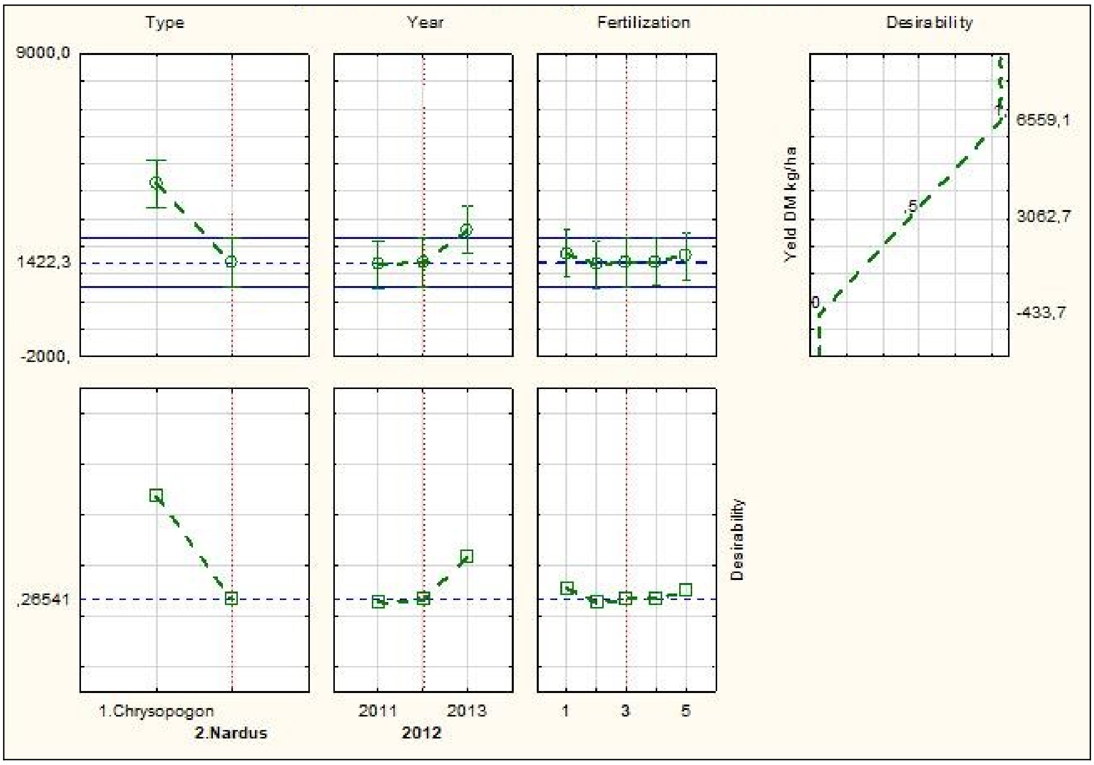

Fig. 2. RSM profiles for predicted values and desirability of factors in meadow *Chrysopogon* and pasture *Nardus* fertilized by leaf fertilized Biostim.

Table 7. Degree of impact of factors on dry matter yield (n = 312). Legend: Degree of Freedom (df); Relationship between analyzed quantities (F); Reliability of the difference between indicators (P <); Partial eta-squared (η^2).

Factors	SS	df	F	P<	η^2(%)	Degree of impact (%)
Type of grassland (meadow or pasture)	215897018.0	1	164.489	0.000000	0.35	63.42
Fertilizing method (mineral or foliar organic)	30039261.6	1	22.887	0.000003	0.07	8.82
Year	69187543.2	2	26.357	0.000000	0.15	20.32
Level of fertilizing	25289245.7	7	2.753	0.008742	0.06	7.43
Mistakes	393759473.6	300				

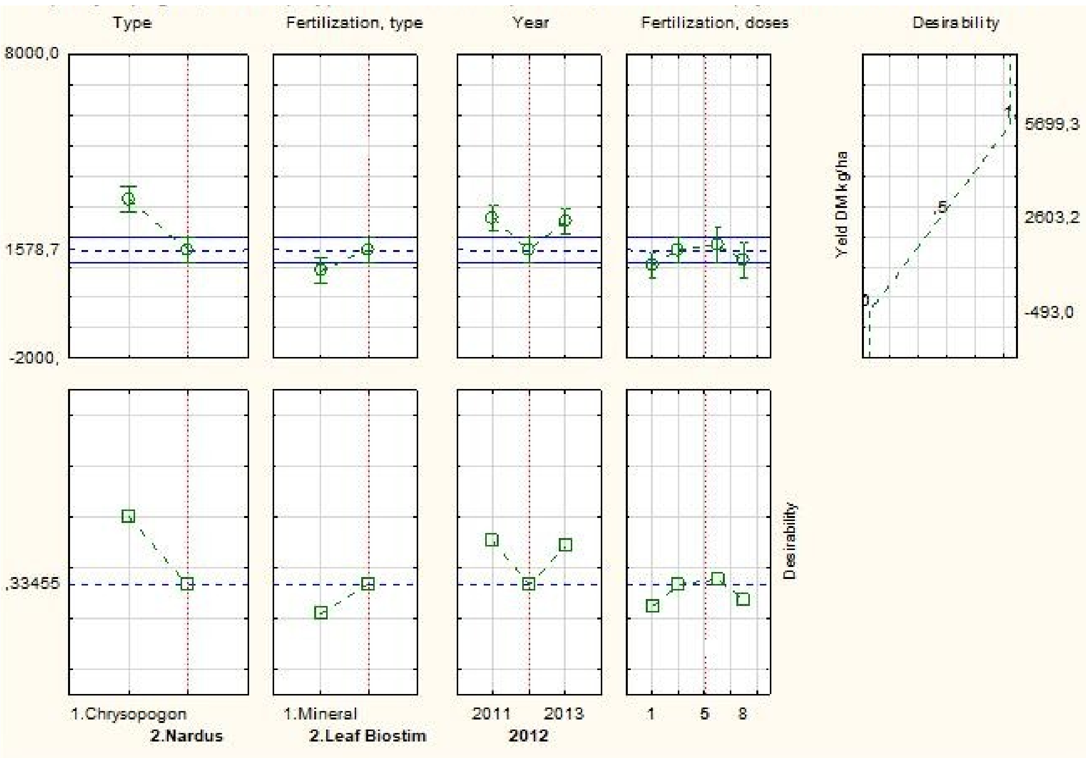

Fig. 3. RSM profiles for predicted values and desirability of factors the type pf the grass (*Chrysopogon, Nardus*), type of fertizilation (Mineral, Leaf Biostim), year and fertilization doses.

Conclusions

In the case of variable fertilization of a meadow of *Chrysopogon gryllus* L. type with mineral nitrogen and phosphorus, the highest yield of biomass is obtained in the variants N_{60} kg/ha (first year), P_{60} kg/ha (second year) and N_{60} kg/ha (third year). The highest amount of biomass was registered in the foliar fertilizing with Biostim at a dose of 3000 ml/ha. The highest yield was registered in a grassland with *Nardus stricta* L. with annual fertilization with N_{60} and P_{60} kg/ha, and with foliar fertilizing with Biostim with a dose of 1000 ml/ha.

There is good regression dependence between productivity and moisture supply, which enables, by means of regression equations, an approximate prediction of biomass yields from natural grassland of *Chrysopogon gryllus* L. type, fertilized with mineral and foliar fertilizers. The determination coefficient R - 0.7 - 0.8 is sufficiently high for the practical determination of productivity by the sum of precipitation during the critical months of April to July. When using the annual or seasonal precipitation, the accuracy is less.

The summarized multifactorial analysis of the impact of factors, such as methods (mineral and foliar organic), fertilization levels, type of grassland and climatic conditions over the years, shows that the type of grassland has the strongest impact on the conditions of the area on the productivity of the grasslands – 63.42%. The year with its specific climatic conditions - rainfall - 20.32%, is in second place in terms of the impact. The fertilizing method, such as mineral fertilizing with N and P or foliar fertilizing with Biostim - 8.82%, is in third place in terms of impact. The level of fertilization (the applied doses of fertilizers and the way of their alternation) - 7.43% has the slightest impact.

The summary RSM analysis shows a slightly higher efficiency of foliar fertilizing for both types of grasses.

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