INFLUENCE OF HARVEST PHENOPHASE ON THE PRODUCTIVITY, COMPOSITION AND STRUCTURE OF VEGETATION COVER OF A *FESTUCA VALESIACA* Schleich. ex. Gaudin GRASSLAND FROM MOLDOVA FOREST STEPPE

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Abstract

Permanent grasslands are an important source of fodder, due to the areas that they occupy, but also to high and good quality production that can be obtained from them. By using a rational management, grassland production may rise considerably. The objective of this study was to determine the effect of harvesting phenophase under the influence of organic and mineral fertilization on the productivity, composition and structure of vegetation cover of a grassland of *Festuca valesiaca* Schleich. ex. Gaudin. The researches were conducted at the University of Agricultural Sciences and Veterinary Medicine Iasi, Ezareni farm (47°05'-47°10' north latitude and 27°28'-27°33' eastern longitude). The experimental factors were represented by the harvesting phenophase, with three graduations: a_1-harvested at plant height of 15-18 cm, a_2-harvested at the ear formation (control) and a_3-harvested to full flowering and fertilization with seven graduations: b_1- unfertilized (control), b_2-$N_{50}P_{50}K_0$ kg·ha^{-1} annually, b_3-$N_{75}P_{75}K_0$ kg·ha^{-1} annually, b_4-$N_{100}P_{100}K_0$ kg·ha^{-1} annually, b_5-10 Mg·ha^{-1} sheep manure annually, b_6-20 Mg·ha^{-1} annually and b_7-30 Mg·ha^{-1} annually sheep manure applied at two years. The results obtained showed that dry matter production was influenced both by the harvest phenophase and the fertilizer doses used, the higher dry matter production values obtained in the fertilized variants with $N_{100}P_{100}K_0$ kg·ha^{-1} annually and 30 Mg·ha^{-1} of two-year-old sheep manure harvested in full-flowering phenophase of the dominant species. Both harvesting in different phenophases, but especially fertilization, led to the modification of structure of vegetation cover by favoring valuable species from fodder point of view.

Key words: permanent grassland, harvest phenophase, biodiversity, dry matter production

The role and functions of meadows are complex and regulate many economic, ecological and social aspects (Vîntu V. *et al*, 2004).

Most grasslands are harvested when the yield of dry matter is highest, their nutritional value being generally lower. Realization the optimum nutritional value of feed requires particular attention, taking into account the stage of development of fodder species (Andueza D. *et al*, 2016).

Degree of maturity of plants or developmental phenophase at the time of harvesting is the main responsible for lowering the nutritional value of feed (Bumb I. *et al*, 2016). The stage of development is an essential factor which causes changes in the quality of feed, being influenced by how fodder crops are managed (Adesogan A.T. *et al*, 2009).

The fodder value of species is strongly influenced by their growth stage when they are harvested or grazed (Ball D.M. *et al*, 2001). The fodder value is highest during vegetative growth and the lowest during the seed formation phenophase (Roşca D., 1971).

The changes what's happening in the structure of the vegetation cover are determined by the morphological and biological characteristics of the plants, the vegetation phase during the harvest period and the level of fertilization (Vîntu V. *et al*, 1993; Poldisek *et al*, 2007).

The use of organic and mineral fertilizers on permanent grassland is a basic measure for increasing the production of phytomas, the doses and combinations to be used must be determined according to the economic and organizational possibilities of the pastoral beneficiary, the static conditions, the structure and the composition of the vegetal cover (Vîntu V. *et al*, 2006).

Fertilization is one of the main measures to increase the production of all crops, but on pastures the fertilizers have a multiple role (Samuil C. *et al*, 2010).

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The paper presents the results experimental obtained from 2018, on *Festuca valesiaca* Schleich. ex. Gaudin permanent grassland, in which the effect of the phenophase harvesting under the influence of organic and mineral fertilization on the productivity and structure of the vegetation cover were taken under observation.

MATERIAL AND METHOD

The field trials were organized on a *Festuca valesiaca* Schleich. ex. Gaudin type plant association situated in Moldavian sylvosteppe, between the geographical coordinates 47°05'-47° 10' north latitude and 27°28'-27°33' eastern longitude, on a slightly inclined ground, with NE exposition.

The vegetation cover is formed mostly of species with low fodder value, the share of valuable species being reduced.

The experience is bifactorial, arranged in randomized plots in three replicates, which to study the effect of phenophase harvesting under the influence of organic fertilization and minerals in different doses, in the increase phytomass and the modification produced in the floristic composition as a result of the changes of soil nutritional status.

The experimental factors were represented by the harvesting stage, with three graduations:

a_1-harvested at plant height of 15-18 cm,

a_2-harvested at the ear formation (control),

a_3-harvested to full flowering,

and fertilization with seven graduations:

b_1-unfertilized (control),

b_2-$N_{50}P_{50}K_0$ kg·ha^{-1} annually,

b_3-$N_{75}P_{75}K_0$ kg·ha^{-1} annually,

b_4-$N_{100}P_{100}K_0$ kg·ha^{-1}anually,

b_5-10 Mg ha^{-1} sheep manure annually,

b_6-20 Mg·ha^{-1} annually and

b_7-30 Mg·ha^{-1} annually sheep manure applied at two years.

Fertilization was done with two types of fertilizer: organic represented by well fermented sheep manure (older than two years) and mineral represented by complex fertilizer with nitrogen and phosphorus ($N_{20}P_{20}K_0$). Fertilizers were manually applied early spring.

Production was expressed in dry matter (DM); the floral composition was determined by the geobotanic method using the visual appreciation scale - the Braun-Blanquet method; the statistical processing of the results has been achieved by variance analysis.

RESULTS AND DISCUSSIONS

Improvement of the soil nutrition regime due to the application of mineral and organic fertilizers had a positive effect on the growth of the *Festuca valesiaca* grassland, the level of production being differentiated according to the applied doses and due to climatic conditions of the year of experimentation.

Analyzing the influence of the studied factors on the dry matter production (*Table 1*), it is observed that the level of the production is different depending on the fertilization variants used, and at the same doses, depending on the harvest phenophase.

Thus, harvesting at the height of the plants of the dominant species of 15-18 cm gave the lowest production of dry matter, of 1.81 Mg·ha^{-1} DM in the unfertilized variant. Of the proposed fertilization variants, the most advantageous in this phenophase were the fertilized mineral variants with $N_{75}P_{75}K_0$ kg·ha^{-1} and $N_{100}P_{100}K_0$ kg·ha^{-1} applied annually, the yield being of 2.31 Mg·ha^{-1} DM and respectively 2.35 Mg·ha^{-1} DM, with statistical differences ensured against control (*Tabel 1*).

The harvesting at the ear formation (control) of the dominant species led to higher production of dry matter compared to the first phenophase, between 1.86 Mg·ha^{-1} DM (control variant) and 2.58 Mg·ha^{-1} DM, in organic fertilized variant with 30 Mg·ha^{-1} of sheep manure applied at two years, the difference from the control being very significant.

Analyzing the production data for full flowering phenophase (*Table 1*) it can be observed that the yields obtained had a positive evolution due to the assimilation by the plants of the fertilizers applied and the accumulation of biomass.

In the unfertilized control, a production of 1.91 Mg·ha^{-1} DM was obtained, and the highest values of dry matter production of 2.65 Mg·ha^{-1} DM and 2.67 Mg·ha^{-1} DM, respectively, were obtained in fertilized variants with $N_{100}P_{100}K_0$ kg·ha^{-1} applied annually and 30 Mg·ha^{-1} of sheep manure applied at two years.

Also, analyzing the results obtained (*Table 1*), it is found that absence of fertilization or the use of small doses ($N_{50}P_{50}$, 10 Mg·ha^{-1} of sheep manure) did not provide statistically assured production increases.

From the analysis of the effect of the harvesting phenophase on the dry matter production (*Table 2*) it was found that the vegetation of the permanent pasture studied was strongly affected by the long-term drought occurring during the active plant growth period.

The results of the harvest phenophase give valuable information on the optimum harvest time.

Table 1

Influence of fertilization and harvest phenophase on the production of dry matter

Variant		DM Production ($Mg \cdot ha^{-1}$)	Difference		Significance
			$Mg \cdot ha^{-1}$	%	
a_1 - harvested at plant height of 15-18 cm	b_1-unfertilized	1.81	-0.05	97.5	
	b_2- $N_{50}P_{50}K_0$	1.97	0.11	106.0	
	b_3- $N_{75}P_{75}K_0$	2.31	0.45	124.1	*
	b_4- $N_{100}P_{100}K_0$	2.35	0.49	126.6	*
	b_5-10 $Mg \cdot ha^{-1}$ sheep manure applied annually	1.97	0.11	106.0	
	b_6-20 $Mg \cdot ha^{-1}$ sheep manure applied annually	2.22	0.36	119.2	
	b_7-30 $Mg \cdot ha^{-1}$ sheep manure applied at 2 years	2.25	0.39	120.8	
a_2 - harvested at the ear formation (C)	b_1-unfertilized (C)	1.86	Control	100.0	Control
	b_2- $N_{50}P_{50}K_0$	2.31	0.45	124.2	*
	b_3- $N_{75}P_{75}K_0$	2.48	0.62	133.4	**
	b_4- $N_{100}P_{100}K_0$	2.49	0.63	133.8	**
	b_5-10 $Mg \cdot ha^{-1}$ sheep manure applied annually	2.15	0.29	115.8	
	b_6-20 $Mg \cdot ha^{-1}$ sheep manure applied annually	2.48	0.62	133.3	**
	b_7-30 $Mg \cdot ha^{-1}$ sheep manure applied at 2 years	2.58	0.72	138.8	**
a_3 - harvested to full flowering	b_1-unfertilized	1.91	0.05	102.7	
	b_2- $N_{50}P_{50}K_0$	2.35	0.49	126.3	*
	b_3- $N_{75}P_{75}K_0$	2.55	0.69	137.1	**
	b_4- $N_{100}P_{100}K_0$	2.67	0.81	143.6	***
	b_5-10 $Mg \cdot ha^{-1}$ sheep manure applied annually	2.20	0.34	118.4	
	b_6-20 $Mg \cdot ha^{-1}$ sheep manure applied annually	2.51	0.65	135.0	**
	b_7-30 $Mg \cdot ha^{-1}$ sheep manure applied at 2 years	2.65	0.79	142.6	***
		LSD 0.01	0.40		
		LSD 0.1	0.54		
		LSD 0.5	0.75		

Thus, in the variant where the harvesting occurred at the ear formation of the dominant species, the yield obtained, of 2.34 $Mg \cdot ha^{-1}$ DM was close to the variant where harvesting took place in fully flowering phenophase (2.41 $Mg \cdot ha^{-1}$ DM), the obtained differences being insignificant (*Table 2*).

In the variant harvested at the height of the dominant species of 15-18 cm there was obtained a production of 2.13 $Mg \cdot ha^{-1}$ DM, inferior to the control but insignificant.

From the obtained results on the influence of organic and mineral fertilizers on the dry matter production (*Table 3*), the positive influence of applied fertilizers, irrespective of their type, on productivity is clearly observed, the efficiency being dependent on the applied dose, in direct correlation with the climatic conditions, especially

with the amount of rainfall and their distribution during the vegetation period.

Administration of mineral fertilizers in doses of $N_{75}P_{75}K_0$ kg·ha^{-1} and $N_{100}P_{100}K_0$ kg·ha^{-1} applied annually has led to obtaining statistically assured production increases of 31-35% (2.45-2.50 Mg·ha^{-1} DM). Also, the administration of sheep manure at doses of 20 Mg·ha^{-1} (annually) and 30 Mg·ha^{-1} (applied at two years) had a positive influence on the productivity of the meadow, by realizing of productions ranging between 2.40-2.49 Mg·ha^{-1}, DM production increases against the control being 29% and 34% respectively (*Table 3*).

Thus, the major role of nitrogen, either from mineral or organic fertilizers, is highlighted in increasing the amount of phytomatous.

Table 2

Influence of harvest phenophase on dry matter production

Variant	DM Production (Mg·ha^{-1})	Difference		Signifi-cance
		Mg·ha^{-1}	%	
a_1	2.13	-0.21	91.0	
a_2 (C)	2.34	Control	100.0	Control
a_3	2.41	0.07	103.0	
	LSD 0.01	0.42		
	LSD 0.1	0.69		
	LSD 0.5	1.29		

Table 3

Influence of organic and mineral fertilization on dry matter production

Variant	DM Production (Mg·ha^{-1})	Difference		Signifi-cance
		Mg·ha^{-1}	%	
b_1 (C)	1.86	Control	100	Control
b_2	2.21	0.35	118.7	
b_3	2.45	0.58	131.4	*
b_4	2.50	0.64	134.5	**
b_5	2.11	0.25	113.3	
b_6	2.40	0.54	129.1	*
b_7	2.49	0.63	134.0	**
	LSD 0.01	0.41		
	LSD 0.1	0.58		
	LSD 0.5	0.82		

Following the determination of the floral composition of the meadows from the studied experience, the type determined is *Festuca valesiaca* Schleich, specific to the forest-steppe zone. In control variant phytocenosis (a_2b_1), the *Poaceae* family is present in the vegetation cover composition with an average participation of 67% (*Table 4*). Of the *Poaceae* species with the highest degree of coverage is *Festuca valesiaca* Schleich. ex Gaudin, 55.5%, followed by *Elymus repens* L. and *Poa pratensis* L. with an average coverage of 9 and 3%, respectively. The *Fabaceae* family participates in the floral composition, averaging 4%. The most representative species in the studied area are *Medicago falcata* L., *Lotus corniculatus* L. and *Medicago lupulina* L. Plants from other botanical families participate in the control variant (a_2b_1) with an average coverage of 48%, of which the species: *Galium verum* L. with a 15% share, *Fragaria viridis* Duchesne with an average coverage of 5.0 %, and *Achillea millefolium* L.

The coverage of the herbaceous vegetation control is 100% (*Table 4*). Phytocoenosis control is made up of a total of 26 species (*Table 4*).

Analyzing the floral structure of the type of meadow studied, following the application of organic fertilization and minerals correlated with the harvest phenophase, we observe that both the dominant species and the codominant species undergo certain modifications (*Table 4*). Thus, the coverage of the species *Festuca valesiaca* Schleich. ex Gaudin is reduced under the influence of all treatments applied, up to 5% in the variant fertilized with $N_{100}P_{100}K_0$ kg·ha^{-1} annually and 20 Mg·ha^{-1} sheep manure applied annually.

The *Fabacee* changes its participation under the influence of mineral and organic fertilizers, increasing its share in most variants, reaching up to 9% in the variant fertilized with $N_{100}P_{100}K_0$ kg·ha^{-1} annually (a_2b_4) and 5% in fertilized variants with $N_{75}P_{75}K_0$ Mg·ha^{-1} applied annually (a_2b_3) and 10 Mg·ha^{-1} annually sheep manure (a_2b_5) (*Table 4*).

Fertilization generated changes in the structure of the vegetal cover. Thus, doses of organic and mineral fertilizers determined the largest number of species changes, increasing from 26 in the control variant (a_2b_1) to 32-33, in the a_2b_3 and a_2b_5 variants.

Another effect was the emergence of new species that were found in the vegetal cover of the experimental field, such as *Convolvulus arvensis* L., *Rumex crispus* L. and *Taraxacum officinale* F.H. Wigg, species found only in fertilized variants with sheep manure.

Table 4

The influence of organic and mineral fertilization on the floristic structure and composition

Variant		b_1	b_2	b_3	b_4	b_5	b_6	b_7
		Average vegetation coverage (%)						
Degree of vegetation coverage (%)	a_1	**95**	**97**	**98**	**96**	**99**	**96**	**96**
	a_2	**100**	**100**	**100**	**100**	**94**	**97**	**97**
	a_3	**100**	**100**	**97**	**100**	**100**	**100**	**97**
Poaceae	a_1	**73**	**82**	**84**	**82**	**73**	**69**	**77**
	a_2	**67**	**75**	**70**	**68**	**68**	**65**	**78**
	a_3	**62**	**68**	**57**	**68**	**68**	**68**	**51**
Elymus repens	a_1	*10*	*20*	*26*	*25*	*19*	*14*	*16*
	a_2	*9*	*16*	*14*	*15*	*14*	*13*	*17*
	a_3	*8*	*14*	*7*	*3*	*12*	*10*	*4*
Festuca valesiaca	a_1	*58*	*60*	*55*	*55*	*50*	*55*	*55*
	a_2	*55*	*56*	*51*	*50*	*51*	*50*	*58*
	a_3	*49*	*53*	*48*	*55*	*55*	*55*	*46*
Poa pratensis	a_1	*5*	*1*	*3*	*2*	*4*	+	*4*
	a_2	*3*	*2*	*4*	*2*	*3*	*2*	*2*
	a_3	*2*	*1*	+	+	*1*	*2*	*1*
Other species of Poaceae	a_1		1					2
	a_2		1	1	1			1
	a_3	3		2	10		1	
Fabaceae	a_1	**4**	**1**	**1**	**1**	**1**	**1**	**1**
	a_2	**+**	**4**	**5**	**9**	**5**	**2**	**+**
	a_3	**4**	**3**	**+**	**3**	**2**	**1**	**1**
Lotus corniculatus	a_1	+	+	+	+	*1*	*1*	+
	a_2	+	*4*	*2*			+	+
	a_3	+	*2*	+	*2*	*1*	+	*1*
Medicago falcata	a_1	*1*	+	+	+	+	+	*1*
	a_2	+	+	+	*4*		*2*	+
	a_3	*4*	+		+	*1*	*1*	+
Medicago lupulina	a_1	+	+	+	+	+	+	+
	a_2	+	+	*3*	*3*	*3*	+	+
	a_3	+			+		+	
Other species of Fabaceae	a_1	3	1	1	1	+	+	+
	a_2	+	+		2	2	+	+
	a_3	+	1	+	1	+	+	+
Forbs	a_1	**18**	**14**	**13**	**13**	**25**	**26**	**18**
	a_2	**33**	**21**	**25**	**23**	**21**	**30**	**19**
	a_3	**34**	**29**	**40**	**29**	**30**	**31**	**45**
Achillea millefolium	a_1	+	*6*	*4*	*2*	*3*	*5*	*3*
	a_2	+	+	+	+	+	*3*	+
	a_3	*2*	*1*	+	*3*	+	*2*	*3*
Fragaria viridis	a_1	*4*	*1*	*2*	*7*	*8*	*5*	*5*
	a_2	*5*	*10*	*12*	*15*	*3*	*9*	*3*
	a_3	*3*	*5*	*20*	*7*	*6*	*6*	*7*
Galium verum	a_1	+	+	*2*	*2*	*4*	*10*	*2*
	a_2	*15*	*4*	*3*	*5*	*6*	*2*	*2*
	a_3	*4*	*5*	*1*	*2*	*5*	*5*	*20*
Other species of forbs	a_1	14	7	5	2	10	6	8
	a_2	13	7	10	3	12	16	14
	a_3	25	18	19	17	19	18	15
Species number	a_1	**25**	**26**	**23**	**24**	**23**	**25**	**28**
	a_2	**27**	**28**	**26**	**32**	**30**	**27**	**33**
	a_3	**27**	**28**	**30**	**31**	**29**	**32**	**28**

CONCLUSIONS

The meadows of *Festuca valesiaca* Schleich. ex Gaudin responds favorably to the improvement of the nutrient regime in the soil, the level of phytomatous productions being influenced by the doses and the type of fertilizer in correlation with the pedoclimatic conditions of the studied stationary.

Fertilization increased the productive yield of the meadow studied by 19-34%, depending on the doses and type of fertilizer.

The best fertilization variants proved to be fertilized with 30 Mg·ha^{-1} of sheep manure applied at two years and $N_{100}P_{100}K_0$ kg·ha^{-1} respectively, the production being 2.49 Mg·ha^{-1} DM and 2.50 Mg·ha^{1}, DM with increases of 34% and 35%, respectively, compared to the unfertilized variant.

Both harvesting in different phenophases, but especially fertilization, led to the modification of structure of vegetation cover by favoring valuable species from fodder point of view.

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