MANAGEMENT OF *Nardus stricta* L. AND *Festuca rubra* L. GRASSLANDS IN THE DORNA BASIN

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Abstract

Permanent grasslands of *Festuca rubra* L. and *Nardus stricta* L. represent an important source of fodder in Dorna Basin. Although they have low productivity and inferior quality, these grasslands are used by grazing or alternative use. Improving soil nutrients regime, through fertilization with manure, causes changes in floristic composition and proportion between species in favor for valuable species, thus, contributing to the increase of production and improvement of quality. Research were conducted in the pedo-climatic conditions of the locality Saru-Dornei, in the period of 2012-2014. The experiment was organized on a field located at an altitude of 940 m, with a terrain slope of 10°, where was studied the effect of fertilization with 20-50 t/ha manure applied annually or every 2 years, on production, biodiversity and sward structure of a *Festuca rubra* L. and *Nardus stricta* L. type grassland. Application of manure resulted in production increases from 87.9 to 120.3% statisticaly assured. Organic fertilization resulted in a decrease of *Nardus stricta* L. species from 47-65% up to 8-17% in favor of valuable species: *Arrhenatherum elatius*, *Festuca rubra*, *Trisetum flavescens*, *Trifolium pratense* and *Trifolium repens*.

Key words: organic fertilization, productivity, biodiversity

In Romania, about 200,000 ha in the mountain region are occupied by *Nardus stricta* L. permanent grasslands. In ordinary conditions of use, by grazing or alternative use, without interventions to improve the soil nutrients regime, such areas are producing low yields, with inferior quality (Păcurar F. et al, 2010; Samuil C. et al, 2013; Vîntu V. et al, 2011).

On average, the productions of *Festuca rubra* L. and *Nardus stricta* L. grasslands ranges from 0.75 to 3.75 t/ha DM, respectively grazing capacity ranges between 0.4 to 1.5 LU·ha^{-1} (Maruşca T. et al, 2010; Velev N.I. and Apostolova I.I., 2011).

Changing the management on these grasslands, through the contribution of organic fertilizers, leads to modifications in sward structure by stimulating valuable species, obtaining higher productions, with superior quality (Lazarevic D. et al, 2003; Kohoutek A. et al, 2005; Tarcău Doina. et al, 2012).

MATERIAL AND METHOD

The research was conducted during 2012-2014 in the locality of Şaru-Dornei, from Dorna Basin, an area with an average annual temperature of +5,1ºC and annual precipitations of 942.3 mm.

The experiment, established in 2007, was placed on a *Festuca rubra* L. and *Nardus stricta* L. type grassland, situated at an altitude of 940 m and a terrain slope of 10°. Here we studied the effect of 5 different organic fertilization rates: v_1 - unfertilized (control variant); v_2 - 20 Mg·ha^{-1} manure applied annually; v_3 - 30 Mg·ha^{-1} manure applied annually; v_4 - 30 Mg·ha^{-1} every two years and v_5 - 50+0+40+0 Mg·ha^{-1} manure in 3 replicates, observing the effect of administration of doses ranging from 20-50 t/ha of well fermented manure at different time intervals, on production, biodiversity and sward structure.

Pastoral value (Vp) was calculated using the formula: Vp = (Σ Ac x Is)/100, where: Ac - mean coverage value for each individual species in the sward; Is - a specific indicator for species forage value, ranging between 0 and 5. Grazing capacity (Cp), was determined using the pastoral value (Vp): Cp = Vp x c (LU·ha^{-1}), where c = 0,5 (0,4-0,6).

In *table 1* is presented the fertilization scheme used in the observation period.

Table 1

Manure doses applied

Experimental variant	2011	2012	2013	2014
v_1 - unfertilized (control)	0	0	0	0
v_2 - 20 Mg·ha^{-1} annual	20	20	20	20
v_3 - 30 Mg·ha^{-1} annual	30	30	30	30
v_4 - 30 Mg·ha^{-1} two-year	30	0	30	0
v_5 - 50+0+40+0 Mg·ha^{-1}	40	0	50	0

RESULTS AND DISCUSSIONS

In the period 2012-2014, on the *Festuca rubra* L. and *Nardus stricta* L. grassland, production of DM varied according to climatic

conditions and the amount of manure applied. Thus, analyzing the influence of organic fertilization on production it was observed that the use of manure doses of 20-50 t/ha, applied every year or every two years, resulted in obtaining 2.50 to 3.11 t/ha DM with increases compared to the control variant between 77-120% (V_4, respectively V_3 and V_5).

Production levels were proportional to manure doses that were applied. Fertilizing with 20 t/ha per year obtained 2.65 t/ha DM, while at the dose of 30 t/ha was recorded an average yield of 3.11 t/ha DM. Application of 30 t/ha every 2 years resulted in the formation of an average production of 2.50 t/ha DM, while the v5 variant has obtained an average production of 3.10 t/ha. Higher production levels were observed at annual application of organic fertilizers compared to application at every two years (*table 2*).

Table 2

Production of dry matter in 2012-2014

Experimental variant		DM Production (Mg·ha^{-1})				%
		2012	2013	2014	Average	
v_1 - unfertilized (control)		1.21^{C}	0.78^{C}	2.24^{C}	**1.41^{C}**	100
v_2 - 20 Mg·ha^{-1} annual		2.65***	1.51***	3.79***	**2.65***	188
v_3 - 30 Mg·ha^{-1} annual		3.05***	2.34***	3.93***	**3.11****	220
v_4 - 30 Mg·ha^{-1} two-year		2.81***	1.79***	2.89*	**2.50***	177
v_5 - 50+0+40+0 Mg·ha^{-1}		3.60***	2.43***	3.27***	**3.10****	220
LSD	*0.5%*	*0.59*	*0.29*	*0,50*	***0.91***	
	0.1%	*0.85*	*0.42*	*0,73*	***1.33***	
	0.01%	*1.28*	*0.63*	*1,09*	***1.99***	

Application of manure resulted in significant changes in sward structure, particularly at doses of 20-30 t/ha applied annually, where the coverage of leguminous species increased from 2-4% to 12-17%. Forbs participation in the sward increased in the period 2012-2014, at similar rates of manure, from 18-23% to 35-43%, and grasses decreased from 71-78% to 42-54%, especially from the decrease of the species *Nardus stricta.* (*figure 1*).

In *table 3* is presented the evolution of the floristic composition and structure of *Festuca rubra* L. and *Nardus stricta* L. grassland under the influence of organic fertilizer application.

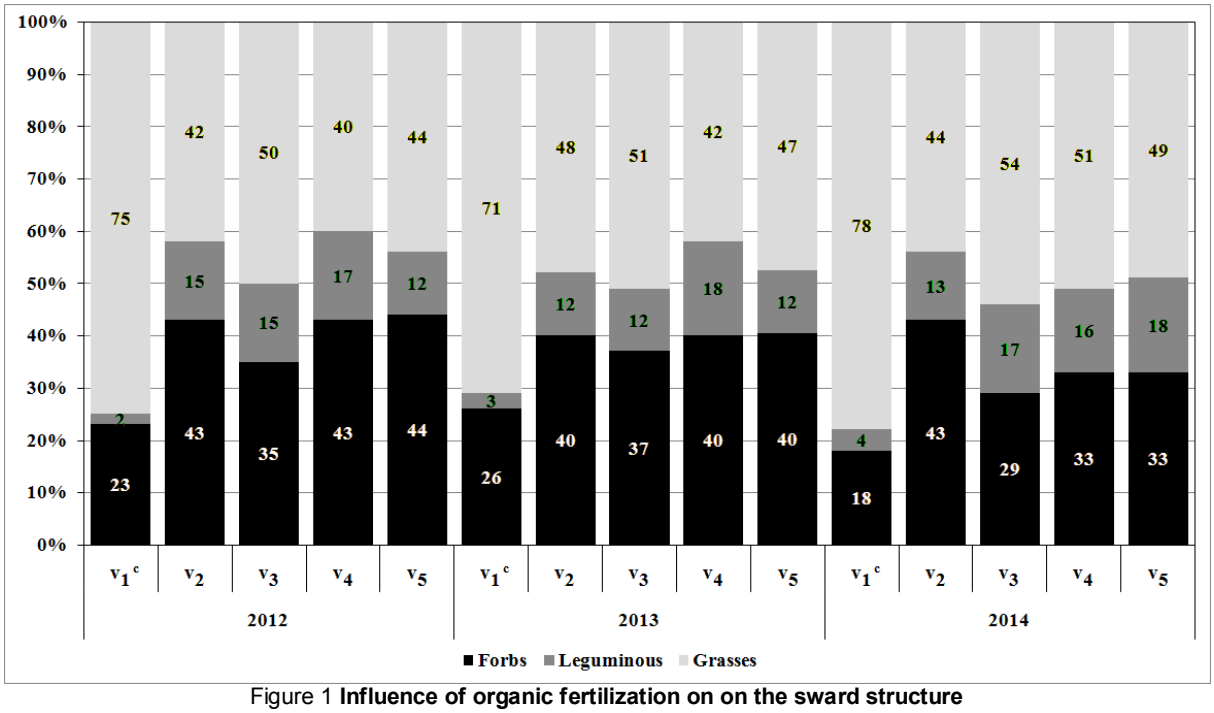

Figure 1 **Influence of organic fertilization on on the sward structure**

Table 3

Influence of organic fertilization on floristic biodiversity

Species	Specific coverage (%)														
	V_1			V_2			V_3			V_4			V_5		
	'12	'13	'14	'12	'13	'14	'12	'13	'14	'12	'13	'14	'12	'13	'14
Agrostis tennuis	3	2	1	4	2	3	7	6	5	3	5	16	6	4	16
Agrostis stolonifera	+	-	-	+	+	-	+	-	+	+	-	+	+	+	-
Anthoxanthum odoratum	2	4	4	3	4	3	4	6	3	7	4	4	3	5	2
Arrhenatherum elatius	-	3	-	1	10	4	5	9	5	+	4	2	2	7	2
Avenastrum pubescens	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-
Brachypodium pinnatum	-	-	-	+	+	-	+	+	-	+	-	+	-	-	-
Briza media	-	-	5	+	+	4	+	+	2	6	3	+	2	2	+
Cynosurus cristatus	-	2	+	3	+	+	2	3	+	1	2	1	+	3	2
Dactylis glomerata	-	-	-	+	4	2	2	5	4	1	2	2	+	1	+
Festuca rubra	5	8	9	6	5	10	7	5	18	7	4	3	6	4	7
Holcus lanatus	-	2	+	3	+	+	+	2	+	-	3	5	+	2	4
Nardus stricta	65	47	59	12	15	13	14	8	15	12	10	17	17	14	13
Phleum pratense	-	-	-	+	+	2	+	-	+	+	-	+	+	-	1
Poa pratensis	-	-	-	+	-	+	-	+	+	+	+	-	+	-	+
Trisetum flavescens	+	3	+	10	8	3	9	7	2	3	5	1	8	5	2
Grasses	**75**	**71**	**78**	**42**	**48**	**44**	**50**	**51**	**54**	**40**	**42**	**51**	**44**	**47**	**58**
Lotus corniculatus	1	+	1	1	+	3	8	3	5	5	3	6	4	2	8
Trifolium pratense	+	2	1	4	6	4	5	5	4	6	8	4	6	6	4
Trifolium repens	1	1	2	10	6	6	2	4	8	6	7	6	2	4	6
Leguminous	**2**	**3**	**4**	**15**	**12**	**13**	**15**	**12**	**17**	**17**	**18**	**16**	**12**	**12**	**18**
Achillea millefolium	5	3	4	6	4	4	8	5	7	11	7	7	8	5	8
Alchemilla vulgaris	2	2	1	5	4	3	5	3	5	6	3	8	5	2	1
Alchemilla xanthochlora	+	-	-	+	+	-	+	-	+	+	+	-	+	-	+
Campanula abietina	1	3	3	4	4	4	+	1	+	1	+	+	7	5	4
Carlina acaulis	1	+	+	+	+	+	-	-	+	+	+	+	+	+	+
Centaurea phrigia	2	3	1	4	3	2	4	3	2	+	3	4	2	1	1
Chrysanthemum leucanthemum	2	3	4	-	4	3	+	3	+	+	5	1	-	2	3
Colchicum autumnale	-	-	-	-	-	-	-	+	+	-	-	-	-	-	+
Cruciata glabra	+	-	+	-	+	-	+	-	-	+	+	-	+	+	-
Galium verum	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-
Hieracium aurantiacum	+	-	-	+	+	+	+	+	+	+	+	-	+	+	+
Hypericum perforatum	1	+	+	2	+	-	+	+	+	-	+	-	+	+	+
Prunella vulgaris	1	-	+	-	+	-	+	-	+	+	+	+	-	-	-
Plantago lanceolata	1	3	2	3	4	6	2	3	3	4	2	1	2	4	2
Potentila erecta	2	2	+	5	2	5	3	3	2	6	4	1	4	1	4
Ranunculus acris	-	2	1	-	1	+	-	+	+	-	1	+	-	1	+
Rinanthus alectorolophus	-	-	-	+	+	+	+	+	-	+	+	+	+	+	+
Taraxacum officinale	2	2	+	6	2	4	5	3	3	5	6	4	5	5	1
Thymus serpilus	1	1	+	-	1	2	2	2	2	1	1	1	+	1	2
Tragopogon orientalis	-	-	-	+	-	-	-	+	-	-	-	-	+	+	+
Veronica chamaedrys	1	2	+	7	11	7	6	11	5	9	8	6	11	13	7
Viola tricolor	1	+	2	1	+	3	-	+	+	-	+	+	+	+	+
Forbs	**23**	**26**	18	**43**	**40**	43	**35**	**37**	29	**43**	**40**	33	**44**	**41**	**33**
Total coverage %	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**99**	**100**
Number of species (Ns)	**27**	**25**	**27**	**33**	**35**	**30**	**34**	**32**	**34**	**33**	**34**	**32**	**35**	**32**	**33**
Pastoral value (Vp)	**1.20**	**1.49**	**1.22**	**2.21**	**2.28**	**2.00**	**2.47**	**2.48**	**2.48**	**2.07**	**2.33**	**2.52**	**1.98**	**2.05**	**2.44**
Grazing capacity (Cp)	**0.60**	**0.75**	**0.61**	**1.11**	**1.14**	**1.00**	**1.24**	**1.24**	**1.24**	**1.04**	**1.17**	**1.26**	**0.99**	**1.03**	**1.22**

Analyzing the influence of manure application on *Festuca rubra* L. and *Nardus stricta* L.,grassland, it was observed that the coverage of the dominant species, *Nardus stricta* L., decreased from 47-65% in the control variant, to only 8 -17% in favor of valuable grass species: *Festuca rubra* L., *Arrhenatherum elatius* and *Trisetum flavescens* whose coverage increased to 10% in fertilized variants (*figure 2*).

Leguminous species had the strongest reaction to the application of manure. The species *Lotus corniculatus,* only present initially in the sward, reached a coverage of 3.8% at fertilization with 30 t/ha manure applied annually; *Trifolium repens* reached a coverage from 2% to 10.6% in the variant fertilized with 30 t/ha manure applied annually; *Trifolium pratense*, following manure application, regardless of the dose or timing of administration, reached a coverage of 4-8% (*figure 3*).

Following organic fertilization was observed an increase in the coverage of forbs species such as: *Veronica chamaedrys*, *Achillea millefolium*, *Taraxacum officinale* which increased their coverage by 5-13%, 4-11% and 1-6% (*figure 4*).

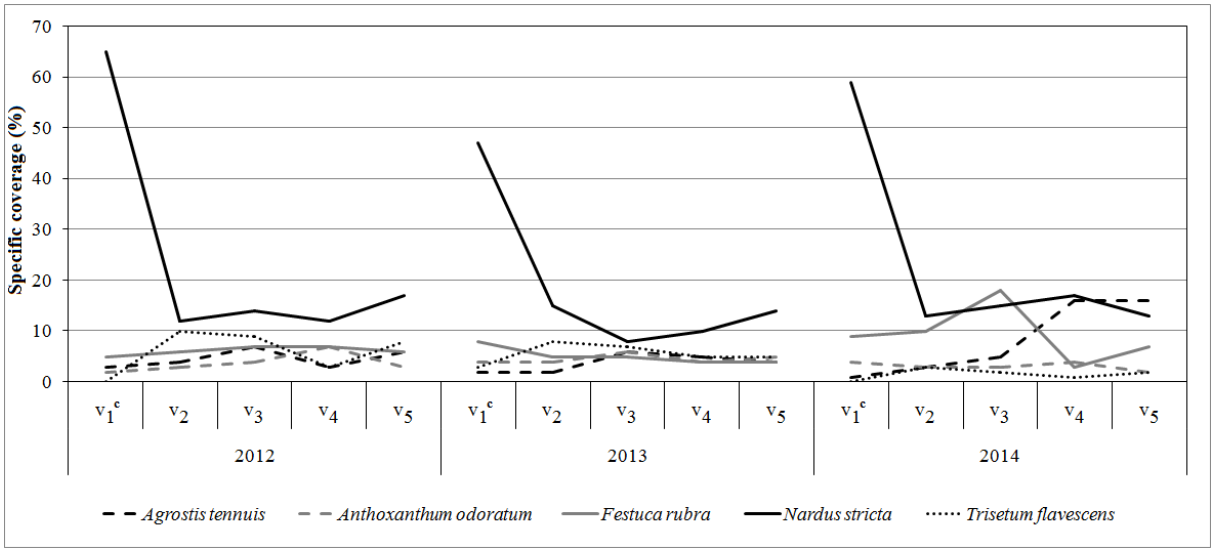

Figure 2 **Influence of organic fertilization on the main grasses Specific coverage**

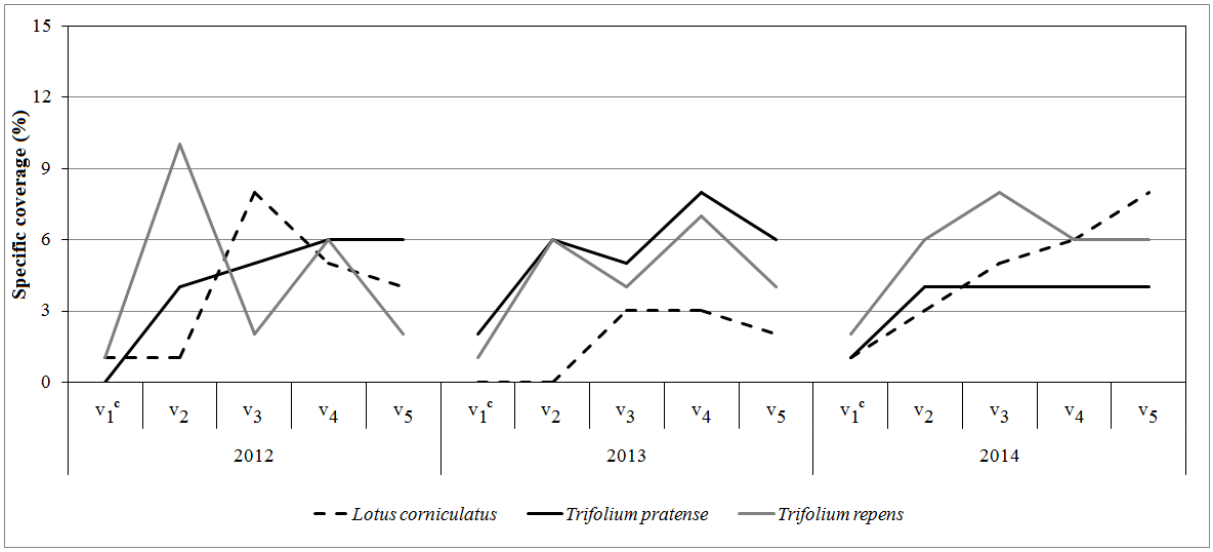

Figure 3 **Influence of organic fertilization on the main leguminous Specific coverage**

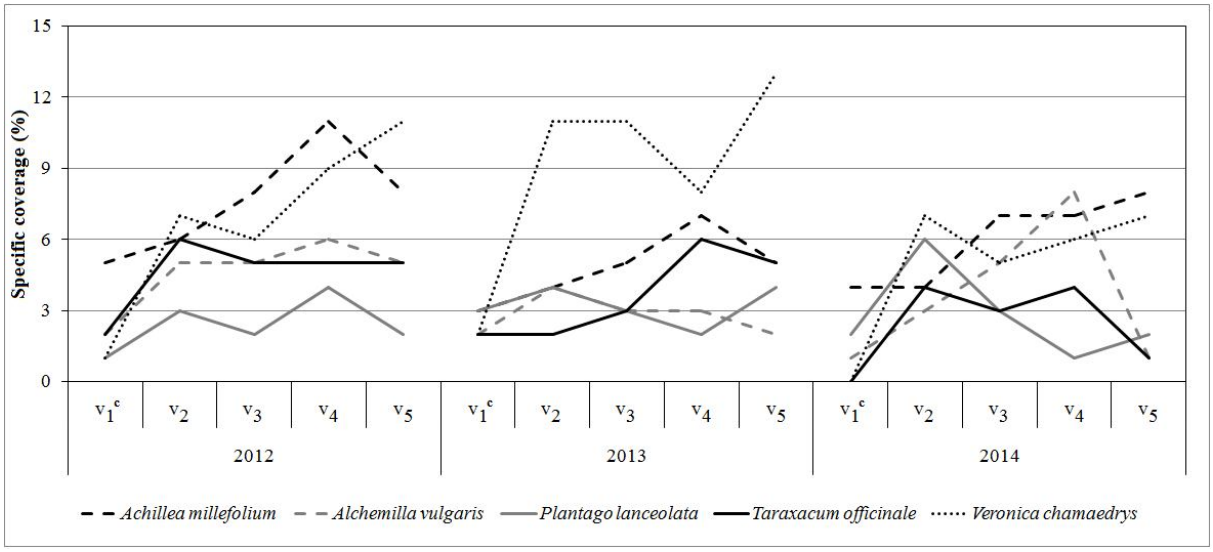

Figure 4 **Influence of organic fertilization on the main forbs Specific coverage**

Fertilizing with manure generated an increase in species number from 25 to 27 species in unfertilized control to a number of 30-35 species at variants fertilized with 20-30 t/ha manure applied annually, and a number of 32-36 species at variants fertilized every two years (*figure 5*).

Also, the pastoral value or grazing capacity were doubled in value, this is due to the replacement of dominant, low forage value, species *Nardus stricta* L., with superior species in terms of forage value .

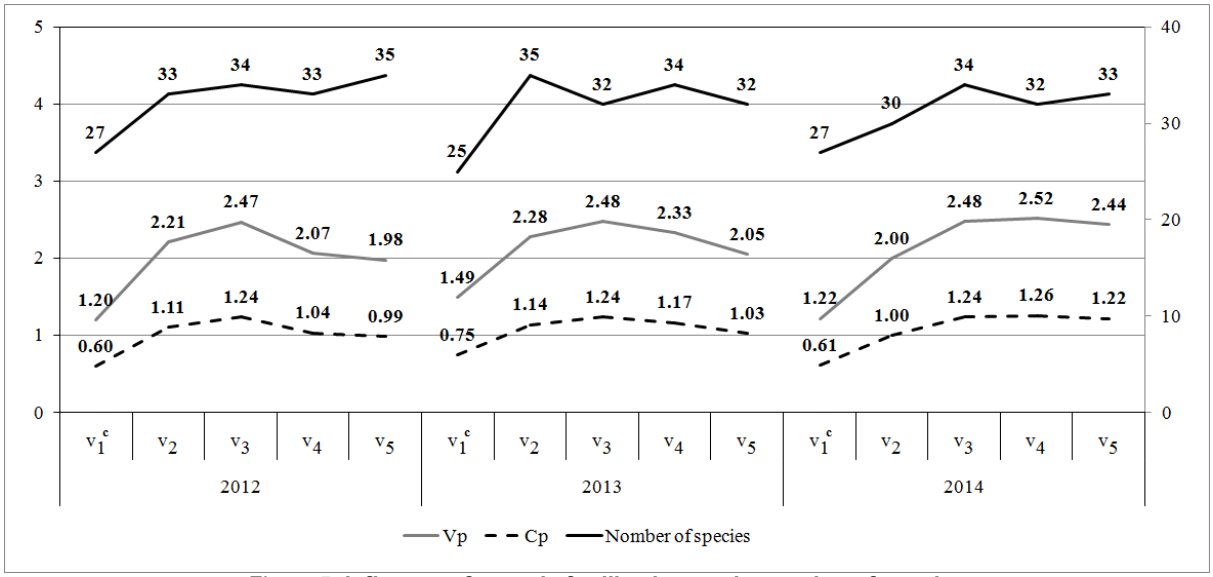

Figure 5. **Influence of organic fertilization on the number of species**

CONCLUSION

Manure application in doses of 20-50 t/ha, applied every year or every two years, resulted in obtaining average yields values between 2.50 to 3.11 t/ha DM with increases compared to the control of 77-120%.

Manure application had a positive effect on sward structure, reducing the coverage of the dominant species, *Nardus stricta* L. in favor of valuable species of grasses (*Festuca rubra, Arrhenatherum elatius* and *Trisetum flavescens)* and leguminous species (*Lotus corniculatus, Trifolium repens and Trifolium pratensis).*

Following organic fertilization has been observed an increase in the coverage of forbs, such as: *Veronica chamaedrys*, *Achillea millefolium*, *Taraxacum officinale*.

Pastoral value and grazing capacity were doubled, as a complex effect of manure application on sward structure and composition.

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