Romanian Journal of Grassland and Forage Crops

The Romanian Society for Grassland
RJGFC No. 30/2024
https://sropaj.ro

Romanian Journal
of Grasslands and Forage Crops

Cluj Napoca 2024

Printed In Cluj Napoca By Academic Press Printers
ISSN 2068 - 3065 (Print)
For Submission Instructions, Subscription And All Other Information Visit: http://www.sropaj.ro

Publisher Romanian Journal of Grasslands and Forage Crops is Published By Academicpress Printers - University of Agriculture Science and Veterinary Medicine Cluj-Napoca, Mănăştur St., No. 3, 400372, Cluj-Napoca, România. Tel: 004/0264-596384, Fax: 004/0264-593792, e-mail: eap@usamvcluj.ro

Typing: - Adrian-Ilie NAZARE

Cover: - Veronica SĂRĂȚEANU

Contents

LONG-TERM INFLUENCE OF IMPROVEMENT FACTORS OF MONTANEOUS *NARDUS STRICTA* GRASSLANDS EVALUATED BY FLORISTIC SURVEY

Teodor MARUȘCA[*,**]

** Research and Development Institute for Grasslands – Brașov*
****** maruscat@yahoo.com

Abstract
In the Bucegi Massif in the Southern Carpathians at an altitude of 1800 m on a grassland degraded by Nardus stricta, an improvement experiment was set up in 1995, through fertilization, calcium amendment, overseeding and reseeding, which was followed for 28 years, until 2023 and currently. Calcium amendment at 2/3 Ah corrected soil acidity, maintaining it at over 5.0 pH compared to 4.6 pH after 28 years, strongly influencing the evolution of the grassy carpet. Based on floristic surveys carried out annually, the production of green fodder mass and the pastoral value of the experimental variants were evaluated with the factors: A. Mineral (NPK), mineral-organic (tillage) and organic fertilization; B. Grassy carpet, natural, overseeding and reseeding; C. Unamended and amended. The best results were achieved in the calcium-amended variants, mineral fertilized in the first stage followed by the organic ones (night paddocking) or exclusively organic ones, overseeded or natural grassy carpet. In these variants, 14.56 t/ha green mass and 83 forage value index was evaluated based on floristic surveys, which ensured 4250 liters per hectare of cow milk in an 85-day grazing season with cows between 2018-2023, demonstrating the long-term effect of the improvement factors taken into study.

Keywords: *Nardus stricta* grasslands, improvement methods, pastoral value, green mass and milk production.

INTRODUCTION

Permanent grasslands invaded by *Nardus stricta* are the most degraded grasslands in the mountainous area of our country (PUȘCARU-SOROCEANU et al. 1963).

Until now, numerous researches have been carried out to improve them through various surface or radical methods (PUȘCARU et al. 1956, SAFTA et al. 1962, RESMERIȚĂ 1969, SAMOILĂ (coord.) 1979, BĂRBULESCU, MOTCĂ 1983 and others).

Usually, the duration of these field researches did not last more than 3-5 years, so the evolution over time of the vegetation of the mountain grasslands dominated by Nardus stricta was not known (MARUȘCA, 2022).

Following long-term experiments carried out at the "Teodor Marușca" Blana-Bucegi

Mountain Grassland Research Base (BCPM) located at 1,800 m altitude, which belongs to the Grassland Research and Development Institute-Brașov, special results were obtained regarding the evolution of the floristic composition of meadows degraded by *Nardus stricta* following the improvement measures applied.

In this paper, an evaluation of the influence of improvement factors through fertilization, calcium amendment, overseeding and reseeding is made for the first time, using exclusively annual floristic surveys and synthetic conversion indices based on long-term experiments.

MATERIAL AND METHOD

Experiments on the improvement of subalpine grasslands located at 1800 m altitude, dominated by Nardus stricta, were started in 1995 at BCPM Blana -Bucegi with the following factors and graduations (3x3x2):

Factor A: Fertilization

1. Fertilization with mineral fertilizers (NPK s.a kg/ha)
- 1996 (150 N, 44 P, 84 K), 1997 (100 N), 1998 (50 N)
- 2004 – 2006 idem 1996 – 1998
- 2011 – 2013 idem 1996 – 1998
- 2018 – 2020 idem 1996 – 1998
- 2024 – idem 1996

2. Mineral and organic fertilization (night paddocking)
- 1996 - 1997 chemically fertilized idem A 1
- 2004 5-night grazing one sheep/sqm
- 2011 5-night grazing one cow/6 sqm
- 2018 idem 2011
- 2024 (to be continued) – idem 2018

3. Organic fertilization (night paddocking)
- 1995 5-night grazing one sheep/sqm
- 2004 idem 1995
- 2011 5-night grazing one cow/6 sqm
- 2018 idem 2011
- 2024 (to be continued) – idem 2018

Factor B: Type of grass cover

1. Semi-natural *Nardus stricta* meadow after clearing of juniper (*Pinus mugo*), a century ago;
2. Overseeded grassland after total herbicide application with "glyphosate" 5 liters per hectare in 1995, harrowed at 2-3 cm and seeded with a mixture of perennial grasses;
3. Reseeded grassland after total herbicide application with "glyphosate", tillage at 10-12 cm depth and seeded with grasses.

Factor C: Calcium amendment

1. Unamended (Control);

2. Amended at 2/3 Ah (7.5 t/ha lime powder CaO);

The floristic composition of the grassland in 1995, before the establishment of the experiment, was as follows: *Nardus stricta* 68%, *Festuca nigrescens* 7%, *Phleum alpinum* 3%, *Agrostis rupestris* 2%, *Festuca ovina ovina* 2%, *Deschampsia caespitosa* 2%, *Anthoxanthum odoratum* 1%, *Deschampsia flexuosa* 1%, *Trifolium repens* 4%, *Potentilla ternata* 5%, *Ligusticum mutellina* 2%, *Polygonum bistorta* 2%, *Campanula abietina* 1%, *Geum montanum* +, *Hieracium aurantiacum* +, *Viola declinata* + and others.

Composition of the herb mixture for overseeding and reseeding: *Festuca pratensis* variety Transilvan 40%; *Phleum pratense* variety Favorit 25%; *Lolium perenne* variety Mara 5%; *Lotus corniculatus* variety Livada 15%; *Trifolium hybridum* Brașov variety 5%, species that are not found in the spontaneous flora.

Mineral fertilization with nitrogen was done with decreasing doses: 150, 100 and 50 kg/ha, imitating as much as possible the effect of animal grazing.

The size of a plot was 18 sqm (6x3), the number of repetitions was 4 and the effective area of the experiment without borders and paths was 432 sqm.

Annual floristic surveys were carried out in two repetitions for each variant.

To determine the green mass production and chemical analyses, 1 sqm was harvested from each repetition plot and the remaining 17 sqm was effectively grazed with dairy cows, so the results are much closer to the conditions in production, compared to imitation by mowing.

The study took into account the last 5 years 2019-2023, which represents the average of the 24-28 years since the radical restoration of the grasslands.

The productivity of the grasslands was evaluated according to the new method based on floristic survey (MARUȘCA 2019).

The evaluation of the production of green fodder mass serves to establish the optimal animal load for each improvement technology in particular.

The pastoral value index multiplied by the conversion coefficient in milk production which is 51.24 determined after 25 years of actual experience with cows next to the experience we are analyzing (MARUȘCA et al. 2018).

In the fall of 2023, 28 years after the application of amendments and processing the upper layer of the soil, average soil samples were taken at a depth of 0-15 cm, a control from the path between the repetitions and from all 18 improvement variants. The analyses were performed according to the standardization method at OSPA Brașov.

RESULTS AND DISCUSSIONS

Due to a very large volume of data obtained 28 years after the application of calcium amendment, overseeding and reseeding, 3 distinct works were published depending on the fertilization system used, namely: mineral (MARUȘCA, 2024 a), organo-mineral (MARUȘCA, 2024 b) and organic (2023). The results regarding the production of green fodder mass, pastoral value and milk production were evaluated based on floristic survey and feed-milk conversion indices (MARUȘCA, 2019; MARUȘCA et al. 2018). In a first phase, a comparative analysis of the agrochemical characteristics of the soil is made 28 years after the establishment of the experiment (Table 1).

Table 1

Agrochemical values of soil depending on improvement technology Blana Bucegi 2023

Specification	pH (H2O)	V_{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Wt. 000	**4.6**	**17.5**	**11.59**	**2.03**	**15**	**190**	**4.12**
111	4.5	21.8	12.26	2.67	29	176	4.52
121	4.5	20.3	12.26	2.49	23	180	4.70
131	4.6	21.8	12.14	2.65	29	196	4.40
Average 101	**4.5**	**21.3**	**12.22**	**2.60**	**27**	**184**	**4.54**
112	4.9	35.3	12.20	4.31	26	166	1.82
122	5.1	46.7	12.32	5.75	27	160	0.84
132	5.0	38.9	12.32	4.79	23	168	1.38
Average 102	**5.0**	**40.3**	**12.28**	**4.95**	**25**	**165**	**1.35**
Average 110	**4.7**	**28.6**	**12.23**	**3.49**	**28**	**171**	**3.17**
Average 120	**4.8**	**33.5**	**12.29**	**4.12**	**25**	**170**	**2.77**
Average 130	**4.8**	**30.4**	**12.23**	**3.72**	**26**	**182**	**2.89**
211	4.8	30.7	12.20	3.75	29	224	2.64
221	4.7	28.3	12.32	3.49	16	180	3.06
231	4.7	27.2	12.32	3.35	19	186	3.10
Average 201	**4.7**	**28.7**	**12.28**	**3.53**	**21**	**197**	**2.93**
212	5.0	40.8	12.26	5.00	21	206	1.26
222	5.0	40.6	12.26	4.98	20	186	1.41
232	5.0	36.4	12.32	4.48	15	156	1.74
Average 202	**5.0**	**39.3**	**12.28**	**4.82**	**19**	**183**	**1.47**
Average 210	**4.9**	**35.8**	**12.23**	**4.38**	**25**	**215**	**1.95**
Average 220	**4.9**	**34.5**	**12.29**	**4.24**	**18**	**183**	**2.24**
Average 230	**4.9**	**31.8**	**12.32**	**3.92**	**17**	**171**	**2.42**
311	4.6	24.7	12.26	3.03	19	188	3.80
321	4.8	32.9	12.32	4.05	18	186	3.34
331	4.8	24.5	12.26	3.00	14	176	4.90

Specification	pH (H2O)	V_{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Average 301	**4.7**	**27.4**	**12.28**	**3.36**	**17**	**183**	**4.01**
312	5.1	41.1	12.26	5.04	19	180	0.92
322	5.0	39.1	12.32	4.82	16	142	1.62
332	5.1	33.0	12.32	4.07	10	158	2.44
Average 302	**5.1**	**37.7**	**12.30**	**4.64**	**15**	**160**	**1.66**
Average 310	**4.9**	**32.9**	**12.26**	**4.04**	**19**	**184**	**2.36**
Average 320	**4.9**	**36.0**	**12.32**	**4.44**	**17**	**164**	**2.48**
Average 330	**5.0**	**28.8**	**12.29**	**3.54**	**12**	**167**	**3.67**

From these data it can be seen that the soil reaction in variants 101 (mineral fertilization, on unamended soil) has a pH of 4.5, 0.1 index lower than the control variant (000), indicating soil acidification.

The calcium-amended variants (102) have an average pH index of 5.0, respectively 0.5 higher than the unamended variants.

Variants 201 (organo-mineral fertilization on unamended soil) have a pH index of 4.7, 0.2 higher than variants 101 due to organic fertilization, continued after a first stage of mineral fertilization.

Variants 202 (amended) are identical to variants 102, both having a pH index of 5.0.

In variants 301 (organic fertilization on unamended soil) the average pH values are similar to variants 201.

In contrast, variants 302 (organic, amended) have the highest pH values, namely 5.1, 0.1 higher than in variants 102 and 202.

The degree of base saturation (VAh, %) is closely related to the soil reaction (pH).

The lowest value of 21.3% VAh was in variant 101 and the highest of 40.3 in variants 102.

The humus content was little influenced by the fertilization and amendment system, with values of 12.2-12.3% average content after 28 years.

The lowest nitrogen (N) index of 2.6 was calculated for variants 101 and the highest of 4.95 for variants 102. In general, the calcium-amended variants have a much higher N index than the unamended variants.

The other average values of mobile phosphorus (P) content ranging between 15-27 ppm and mobile potassium (K) ranging between 160-197 ppm, are extremely heterogeneous, due to the different consumption of plants in the meadows.

There are large differences in the exchangeable aluminum content with variations from 1.35 me/100 g soil for the amended variants 102 to 4.54 me/100 g soil for the unamended variants 101, which exceed by 0.42 me/100 g soil, the control variant (000).

Regarding the influence of the type of grass cover on the agrochemical characteristics of the soil on amended and unamended soil, no significant differences were found. Finally, a general analysis of the influence of the fertilization system, the type of grass cover and calcium amendment on the agrochemical characteristics of the soil was made (Table 2).

Table 2

Influence of technological factors on agrochemical characteristics after 28 years (1995-2023)

Specification	pH (H2O)	V_{Ah} (%)	Humus (%)	IN	Mobile phosphor* ppm	Mobile potassium ppm	Exchangeable aluminium me/100g soil
Wt	**000**	4.6	17.5	11.59	2.03	15	190
A	**100**	4.8	30.8	12.25	3.78	26	174
	200	4.9	34.0	12.28	4.18	20	190
	300	4.9	32.6	12.29	4.00	16	172
	Difference(%)						
	100-000	104	176	106	186	174	92
	200-000	106	194	106	206	133	100
	200-100	102	110	100	110	76	109
	300-000	107	186	106	197	107	90
	300-100	103	106	100	106	61	98
	300-200	100	96	100	96	80	90
B	**010**	4.8	32.4	12.24	3.97	24	190
	020	4.9	34.7	12.30	4.26	20	172
	030	4.9	30.3	12.28	3.72	18	173
	Difference(%)						
	010-000	105	185	106	195	159	100
	020-000	105	198	106	210	133	91
	020-010	101	107	100	107	133	91
	030-000	106	173	106	183	122	91
	030-010	101	93	100	94	77	91
	030-020	101	87	100	87	92	101
C	**001**	4.6	25.0	12.25	3.07	24	191
	002	5	39.8	12.28	4.89	22	174
	Difference(%)						
	001-000	100	143	107	101	160	100
	002-000	109	227	106	241	148	91
	002-001	108	159	100	159	92	91

Note:
A: fertilization, 100 (mineral), 200 (organo-mineral), 300 (organic);
B: grassy carpet, 010 (natural), 020 (overseeded), 030 (reseeded);
C: calcium amendment, 001 (unamended), 002 (amended).

Thus, on average, the A factor (fertilization) variants 200 (organo-mineral) proved superior to 100 and 300, for most agrochemical characteristics.

The B factor (grass carpet type) the most valuable proved to be the 020 (overseeding) variants followed by 010 (natural) and 030 (reseeding).

This result confirms the superiority of the superficial intervention on the degraded grass carpet top soil also found in other older experiences on Nardus stricta grasslands from Vlădeni, Brașov County, where overseeding after total herbicide application with "Gramoxone" gave the best results. (MARUȘCA, 1977).

The strongest effect on the agrochemical characteristics of the soil was the calcium amendment in all fertilization systems (100, 200, 3000 and types of grass carpet (010, 020, 030) explained in detail in the first part of the results of this long-term experience.

The agrochemical characteristics of the soil modified by the grassland improvement factors have a direct influence on the floristic composition (Table 3, part I and II).

Thus, on average, in the years 2019-2023, mineral fertilization (100) favored more the species of the spontaneous flora *Agrostis capillaris* 25.2%, *Festuca nigrescens* 10.7%, *Poa media* 6.5%, *Agrostis rupestris* 6%, *Festuca ovina* 5.5% and the maintenance of the species *Nardus stricta* 4.6%.

Mineral fertilization followed by organic fertilization stimulated the species *Poa pratensis* 26.5%, *Trifolium repens* 38.5% and *Taraxacum officinale* 4% and the exclusively organic one by night paddocking (300) stimulated in a lower proportion the same species as variant 200, to which is added *Polygonum bistorta* 0.4% absent in variants 100 and 200.

The former dominant species Nardus stricta was completely removed from the grassy carpet of variants 200 and 300.

Regarding the type of grassy carpet, it is found that in the natural one (010) *Poa pratensis* 35.1%, *Trifolium repens* 16.1%, *Festuca nigrescens* 12.1%, *Ligusticum mutellina* 5.9%, *Taraxacum officinale* 3.5%, *Deschampsia flexuosa* 3.3% and *Campanula serrata* 2.1% are maintained in a higher proportion.

By total herbicide application and overseeding (020) the specie *Phleum pratense* was stimulated 15.3% and by reseeding (030) the species *Agrostis capillaris* 34%, *Agrostis rupestris* 5.5% and *Poa media* 4.6%.

In the variants without amendment (001) the following species are in higher proportion: *Agrostis capillaris* 23.6%, *Festuca nigrescens* 11.7%, *Poa media* 6.9%, *Agrostis rupestris* 4.4%, *Deschampsia flexuosa* 4%, *Potentilla ternata* 3%, *Nardus* *stricta* 2.8%, *Deschampsia caespitosa* 1% and *Anthoxanthum odoratum* 0.7%.

Table 3

The influence of technological improvement factors on floristic composition (part I)

No.	Species	Indices		A. Fertilisation			
		F	M	Average (%)			
				100	200	300	X00
G	**Gramineae**	**x**	**x**	**77.5**	**69.1**	**68.0**	**71.5**
1	*Agrostis capillaris*	7	5	25.2	16.8	21.3	21.1
2	*Agrostis rupestris*	5	1	6.0	1.6	3.1	3.5
3	*Anthoxanthum odoratum*	5	3	1.0	0.2	0	0.4
4	*Deschampsia caespitosa*	3	0	1.2	1.0	0.4	0.8
5	*Deschampsia flexuosa*	4	3	5.5	0.5	0.4	2.1
6	*Festuca ovona ovina*	5	4	0.5	0	0	0.2
7	*Festuca nigrescens*	7	5	10.7	8.8	9.5	9.7
8	*Nardus stricta*	3	0	4.6	0	0	1.5
9	*Poa annua*	7	2	0	0.2	0	0.1
10	*Poa media*	5	2	6.5	3.8	2.5	4.2
11	*Poa pratensis*	8	6	9.5	26.5	20.0	18.7
12	*Phleum alpinum*	7	2	1.6	0.3	0.7	0.8
13	*Phleum pratensis*	9	8	5.5	9.8	10.1	8.5
L	**Leguminosae**	**x**	**x**	**6.3**	**19.3**	**20.8**	**15.4**
14	*Trifolium repens*	8	5	6.3	38.5	20.8	21.9
AF	**Other families**	**x**	**x**	**16.2**	**11.6**	**11.2**	**13.1**
15	*Campanula abietina*	3	0	0.2	0.9	0.5	0.5
16	*Campanula serrata*	3	0	1.9	1.6	0.6	1.4
17	*Geum montanum*	4	1	1.2	0.9	0	0.7
18	*Hieracium aurantiacum*	4	2	0.8	0.9	0.5	0.7
19	*Lingusticum mutellina*	7	1	5.2	0.9	2.0	2.7
20	*Polygonum bistorta*	5	4	0	0	0.4	0.1
21	*Potentilla ternata*	4	1	4.6	0.7	0.9	2.0
22	*Rumex acetosella*	3	0	0.2	0.3	0.1	0.2
23	*Taraxacum officinalis*	7	3	0.3	4.0	3.9	2.7
24	*Viola declinata*	3	0	0.8	0.1	0.3	0.4
25	Alte specii	3	0	1.1	1.5	2.3	1.7
PV	**Pastoral value (ind.)**			**69.2**	**80.7**	**79.2**	**76.3**
GM	**Green mass production (t/ha)**			**9.16**	**13.40**	**13.15**	**11.90**

By calcium amendment (002), the species *Poa pratensis* 23.9%, *Trifolium repens* 20.2%, *Phleum pratense* 11.2% and *Taraxacum officinale* 3.1% are particularly stimulated, the species *Nardus stricta* being eliminated from the grassy carpet.

Table 3

The influence of technological improvement factors on floristic composition (part II)

No.	A. Fertilisation			B. Grass carpet						C. Amendment		
	Difference (%)			Average (%)			Difference (%)			Average (%)		Dif. (%)
	200 100	300 100	300 200	010	020	030	020 010	030 010	030 020	001	002	002 001
G	**89**	**88**	**98**	**65.8**	**73.3**	**75.5**	**111**	**115**	**103**	**75.8**	**67.2**	**89**
1	67	85	127	4.3	25.1	34.0	578	784	136	23.6	18.6	79
2	27	52	196	0.9	4.3	5.5	474	611	129	4.4	2.7	62
3	16	0	0	0.7	0.1	0.3	14	43	300	0.7	0.1	10
4	83	30	37	0.7	0.5	1.2	68	168	247	1.0	0.7	69
5	8	7	89	3.3	1.4	1.7	44	51	116	4.0	0.2	6
6	0	0	0	0.4	0.1	0	27	9	33	0.3	0	11
7	82	88	107	12.1	8.1	8.8	67	73	109	11.7	7.6	64
8	0	0	0	2.4	0.7	1.5	30	63	214	2.8	0.2	8
9	0	0	0	0.2	0	0	0	0	0	0.1	0	0
10	58	39	67	4.0	4.2	4.6	103	114	110	6.9	1.5	22
11	280	212	75	35.1	13.2	7.7	38	22	58	13.4	23.9	178
12	16	42	260	1.5	0.2	0.6	13	40	300	1.2	0.5	40
13	178	183	103	0.4	15.3	9.6	3833	2408	63	5.7	11.2	198
L	**308**	**333**	**108**	**16.1**	**15.6**	**14.5**	**97**	**90**	**93**	**10.6**	**20.2**	**190**
14	616	333	54	16.1	15.6	14.5	97	90	93	10.6	20.2	190
AF	**72**	**69**	**97**	**18.1**	**11.1**	**9.8**	**61**	**54**	**88**	**13.6**	**12.5**	**92**
15	600	300	50	0.4	0.5	0.8	108	192	179	0.6	0.4	58
16	84	32	38	2.1	1.1	1.3	52	63	122	1.3	1.5	116
17	71	0	0	0.8	0.2	0.9	25	117	467	0.5	0.9	173
18	106	63	59	0.3	0.5	1.3	150	390	260	1.0	0.5	48
19	16	38	229	5.9	1.5	0.5	26	8	30	2.7	2.6	95
20	0	0	0	0	0.1	0.3	0	0	400	0.1	0.1	100
21	14	19	131	1.9	0.8	1.4	40	71	178	3.0	1.0	33
22	150	25	17	0.3	0.2	0	50	10	20	0.3	0.1	38
23	1333	1300	98	3.5	2.7	2.1	76	60	79	2.3	3.1	134
24	13	38	300	0.3	0.2	0.6	78	211	271	0.4	0.4	100
25	136	209	153	2.7	1.3	0.8	49	31	63	1.3	2.1	158
PV	**117**	**114**	**98**	**75.8**	**78.4**	**75.0**	**103**	**99**	**96**	**72.3**	**80.4**	**111**
GM	**146**	**144**	**98**	**10.97**	**12.85**	**11.79**	**117**	**107**	**92**	**10.5**	**13.30**	**127**

Next, after the influence of improvement factors on floristic composition, their influence on green fodder production is presented (Table 4).

Table 4

The influence of technological improvement factors on green fodder production and grazing capacity

Factor	Variant	Average production (t/ha)	Optimal animal loading (LU/ha)	%
A Fertilisation	100	9.16	1.66	100
	200	**13.40**	**2.43**	**146**
	300	13.15	2.38	144
B Grass carpet	010	10.97	1.99	100
	020	**12.85**	**2.33**	**117**
	030	11.79	2.13	107
C Amendment	001	10.50	1.90	100
	002	**13.30**	**2.41**	**127**

From these data it results that the greatest influence on production has the organo-mineral fertilization (200) with 46% followed by calcium amendment (002) with 27% and overseeding with 17% compared to variants 100, 010 and 001 taken as a control.

The production of green mass is between 9.16 to 13.4 t/ha in variants 100 and 200, which allow a loading with 1.66 to 2.43 UVM/ha.

The same variants (200, 020 and 002) also have the highest pastoral value and milk production (Table 5).

Table 5

Influence of technological improvement factors on pastoral value and milk production in 85 days of grazing season

Factor	Variant	Pastoral value (ind)	Milk production (l/ha)	%
A Fertilisation	100	69.2	3.545	100
	200	**80.7**	**4.135**	**117**
	300	79.2	4.058	114
B Grass carpet	010	75.8	3.880	100
	020	**78.4**	**4.020**	**103**
	030	75.0	3.840	99
C Amendment	001	72.3	3.704	100
	002	**80.4**	**4120**	**111**

At the pastoral value of 69.02 (good) to 80.7 (very good) 3545 liters of milk per hectare to 4135 l/ha were evaluated in 85 days of optimal grazing season in transhumance at 1800 m altitude.

The highest effect on milk production was had by organo-mineral fertilization with 17%, amendment with 11% and reseeding with 3%, compared to controls, similar to green mass production.

From this point of view, less milk per hectare was evaluated on the reseeded variants than on the grassland with natural grass carpet, which indicates the maximum duration of a reseeded grassland of up to 25 years in the subalpine level.

Finally, based on published data (MARUȘCA, 2023, 2024 a,b) separately for the mineral (100), organo-mineral (200) and organic (300) fertilized variants, the weakest and best improvement variants with their productivity are presented (Table 6).

Table 6

Comparative situation between the worst and the best three options for improving the *Nardus stricta* grasslands

Variant **A - fertilisation** **B – grass carpet** **C - amendment**		**Green mass production (t/ha)**	**Pastoral value (ind.)**	**Milk production (L/ha)**
I Low variants				
111 mineral, natural, unamended		5.45	59.5	3050
131 mineral, reseeded, unamended		6.71	60.4	3095
121 mineral, overseeded, unamended		7.42	62.7	3215
Average I (low variants)		**6.53**	**60.9**	**3120**
II Good variants				
222 organo-mineral, overseeded, amended		15.02	84.8	4345
212 organo-mineral, natural, amended		14.31	82.1	4205
322 organic, overseeded, amended		14.36	82.0	4200
Average II (good variants)		**14.56**	**83.0**	**4250**
Difference II-I	+, -	**+ 8.03**	**+ 22.1**	**+ 1130**
	%	**222**	**136**	**136**

The variants with the lowest pastoral values (PV), green mass production (GM) and milk (L) assessed as weak were in order 111,131 and 121 mineral fertilized (NPK) on unamended soil on all types of grassy carpet, which was evaluated on average 6.53 t/ha MV; 60.9 VP and 3120 L/ha.

The variants with the highest PV, GM and milk production which are the best recommended ones, were 222, 212 and 322, amended with calcium, organically fertilized (night paddocking) or organo-mineral, overseeded and natural, where 14.56 t/ha GM was evaluated with 222% more than in the weak variants; 83 PV and 4250 L/ha, with 136 higher than the first 3 weaker variants.

These data are very close to the results obtained in a parallel experience with dairy cows where on the amended version, natural grassy carpet fertilized initially mineral (NPK) and then organically (sowing), an average of 4070 liters of milk per hectare was obtained over 25 years in a grazing season of 85 days (MARUȘCA et al. 2022).

CONCLUSIONS

Subalpine grasslands dominated by Nardus stricta located on strongly acidic soils can be improved by various methods in long-term experiences with very good results.

The best improvement options are calcium amendment to correct soil acidity with an effect of over 30 years, total herbicide application with glyphosate and overseeding, fertilization with mineral fertilizers (NPK) for 3 consecutive years, followed by organic fertilization (soil fertilization) with sheep or cattle once every 6 years.

The evaluation of green mass production and the pastoral value index based on floristic survey, followed by the application of the feed-milk transformation coefficient are sufficiently accurate to establish the best options for improving permanent grasslands.

REFERENCES

1. Bărbulescu C, Motcă Gh., 1983, *Pășunile munților înalți,* Ed. "Ceres"
2. Marușca T., 1977, *Sisteme de înființare a pajiștilor temporare pe suprafețele dominate de Nardus stricta L,* Lucrări științifice ale Stațiunii Centrale de Cercetări pentru Cultura Pajiștilor Măgurele-Brașov, vol. III, București
3. Marușca T., Blaj V. A., Mocanu V., Andreoiu Andreea C., Zevedei P. M., 2018, *Long term influence of botanical composition of alpine pastures on cow milk production*, Proceedings of the 27th General Meeting of the European Grassland Federation, EGF, Volume 23, Pp. 283-285, Cork, Ireland, 17-21 iunie, ISBN 978-1-84170-643-6
4. Marușca T., 2019, *Contributions to the evaluation of pasture productivity using the floristic releve*, Romanian Journal of Grassland and Forage Crops BDI Nr. 19, Cluj – Napoca, pp. 33- 47, ISSN 2068-3065,
5. Marușca T**.,** 2021, *Multiannual dinamics in species composition and productivity of an ammeliorated subalpine grassland managed with dairy cow*, Romanian Journal of Grassland and Forage Crops , Cluj Napoca, nr.24 pp. 51-61, ISSN 2068-3065
6. Marușca T**.** 2022, *Praticultură și pastoralism în cercetarea științifică*, Editura Universității Transilvania din Brașov, 311 pagini, ISBN 978-606-19-1565-1
7. Maruşca T**.,** Blaj V.A., Mocanu V., 2022, *Long-term effect of the technologies and rational use of Nardus stricta subalpine pastures from the Carpathian mountains*, Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 11, Number 2, pp. 34-42
8. Maruşca, T. (2023), The long-term influence of the improvement factors of Nardus stricta grasslands in the Bucegi mountains, the organicly

fertilized variant, *Journal of Montology/ Jurnalul de Montanologie*, 19, pp. 7-15.
9. Marușca T.,2024 a, *The long-term effect of ecological reconstruction factors of Nardus stricta Grasslands from the Bucegi Massiv, the organo-mineral fertilized variant*, Revista Acta Montanologiae ICDM Cristian, nr.2, Revistă sub auspiciile ASAS, revistă de cunoaștere și cercetare științifică a culturii și civilizației rural montane, Anul II, nr.1, pag. 15-24.
10. Marușca T., 2024 b, *Long-term Effect of Improvement Factors of Nardus Stricta, Grasslands, the Mineral Fertilized Variant,* Annals of the Academy of Roman ian Scientists Series Agriculture, Silviculture and Veterinary Medicine Sciences Online ISSN 2344 – 2085 Volume 13, Nr 2
11. Puşcaru D., Puşcaru- Soroceanu Evdochia, Păucă Ana, Şerbănescu I., Beldie Al., Ştefureac Tr., Cernescu N., Saghin F., Creţu V., Lupan L., Taşcenco V., 1956, *Păşunile alpine din Munţii Bucegi,* Edit. Acad. Române, Bucureşti
12. Puşcaru- Soroceanu Evdochia, Pușcaru D., Buia Al., Burduja C., Csűrös St. Grîneanu A., Niedermaier K., Popescu C.P., Răvăruț M., 1963, *Păşunile şi fâneţele din R.P.Română, Studiu geobotanic și agroproductiv*, Editura Academiei R.P.R., Bucureşti
13. Rezmeriță I., 1969, *Pajiștile Masivului Vlădeasa, Flora, vegetația și potențialul productiv,* Teză de doctorat, Institutul Agronomic Timișoara
14. Samoilă Z., (sub coord.), 1979, *Pajiştile din Banat, sporirea producției și îmbunătățirea calității lor,* Redacţia de propagandă tehnică agricolă, București.

PRODUCTIVITY ASSESSMENT OF THE GRASSLANDS FROM CRIȘUL REPEDE UPPER BASIN (APUSENI MOUNTAINS)

Teodor MARUȘCA*,*, POP Iulia Florina **, DRAGOȘ Marcela M. *, COMȘIA Cristina C. *, PORR Cristina I. ***

** Research and Development Institute for Grasslands – Brașov*
*** University of Oradea*
*******maruscat@yahoo.com

Abstract

Permanent grasslands from the Crișu Repede upper basin, between 532 - 1837 m altitude in the Apuseni Mountains, have a high biodiversity, represented by the 57 species of cormophytes in an association. The average productivity of the 17 grassland associations is quite low, achieving an average of 2.48 t/ha of green fodder mass, which ensures a load of 0.34 LU/ha in a 120-day grazing season. At the level of phytosociological alliances (habitats), the highest productivity was evaluated at Cynosurion (As. Festuco-Agrostetum capillaris), with 13.3 t/ha of green mass, which allows a load of 1.7 LU/ha in a 120-day grazing season at 1200 m altitude and can reach 67.3 pastoral value with almost 5000 liters of milk per hectare. Much lower results of 100 - 300 liters per hectare were evaluated in the Molinion, Deschampsion and Rumicion alliances with degraded vegetation from a forage point of view. The productivity data of the alliances (habitats) are economic indices necessary for the preparation of pastoral arrangements and optimal management of the grasslands.

Keywords: mountain grasslands, pastoral value, evaluation of green mass, milk production, grassland associations.

INTRODUCTION

In geobotanical research in the Romanian Carpathians, the main objective was to identify and classify grassland phytocenoses, with few references to green mass production and their fodder quality, which required determinations by weighing and chemical analysis of samples collected in fenced spaces, which are more difficult to perform in the field. The evaluation of these economic productivity parameters based on floristic surveys is accurate enough to be generalized (MARUȘCA, 2019).

These data on the production and fodder quality of grasslands are necessary for the preparation of pastoral development projects and further for their correct management in accordance with environmental protection and biodiversity conservation.

This paper provides new reference data for evaluating the productivity of permanent grasslands in the Apuseni Mountains, where animal husbandry has long traditions.

MATERIAL AND METHOD

To evaluate the productivity of the grasslands, floristic surveys from the doctoral thesis entitled "Floristic, phytocoenological, ecological and bioeconomic study of the ecosystems in the Criș Repede upper basin, Valea Iadei - Valea Drăganului interfluve" were used, prepared by biologist Iulia Florina Pop, under the coordination of prof. dr. Petru Burescu from the University of Oradea, defended this year (2024). The outline of the grassland associations was as follows:

Class ***THLASPIETEA ROTUNDIFOLII*** Br.-Bl. 1926
Order ***ANDROSACETALIA ALPINAE*** Br.-Bl. 1926
Alliance ***Festucion pictae*** Krajina 1933
1. *Festucetum pictae* Krajina 1933

Class ***JUNCETEA TRIFIDI*** Klika et Hadač 1944
Order ***CARICETALIA CURVULAE*** Br.-Bl. in Br.-Bl. et Jenny 1926
Alliance ***Loiseleurio-Vaccinion*** Br.-Bl. 1926
2. *Cetrario-Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. et Jenny 1926 corr. Grabherr in Grabherr et Mucina 1993

Class ***NARDO-CALLUNETEA*** Preising 1949
Order ***NARDETALIA*** Oberdorfer
Alliance ***Potentillo-Nardion*** Simon 1959
3. *Festuco rubrae-Nardetum strictae* Csürös et Resmeriță 1960
4. *Violo declinatae*-Nardetum Simon 1966
5. *Potentillo-Festucetum ovinae* Resmeriță (1965) 1969, 1970
Alliance ***Genistion pillosae*** Duvigneaud 1942
6. *Vaccinio-Callunetum vulgaris* Büker 1942

Class ***BETULO-ADENOSTYLETEA*** **Br-.Bl.** et R.Tüxen 1943
Order ***ADENOSTYLETALIA ALLIARIAE*** *Br.-Bl. 1931*
Alliance ***Calamagrostion*** **villosae** Pawlowski et al. 1928
7. *Phleo alpini-Deschampsietum caespitosae* (Morariu 1939) Coldea 1983

Class ***MOLINIO-ARRHENATHERETEA*** R.Tüxen 1937
Order ***MOLINIETALIA CAERULEAE*** Koch 1926
Alliance ***Molinion caeruleae*** Koch 1926
8. *Junco-Molinietum* Preising 1951
Order ***ARRHENATHERETALIA*** R.Tüxen 1931
Alliance ***Cynosurion*** R.Tüxen 1947
9. *Festuco rubrae-Agrostetum capillaris* Horvat 1951
Order ***POTENTILLO-POLYGONETALIA*** R.Tüxen 1947
Alliance ***Potentillion anserinae*** R.Tüxen 1937
10. *Potentilletum anserinae* Felföldy 1942
11. *Ranunculetum repentis* Knapp ex Oberdorfer 1957
12. *Potentilletum reptantis* Ekiás 1974 em. I.Pop 1978
Suballiance ***Juncenenion effusi*** Westhoff et Van Leeuwen ex Hejný et al. 1979

13. *Juncetum effusi* Soó (1931) 1949
14. *Agrostetum caninae* Hargitai 1942

Order ***DESCHAMPSIETALIA CAESPITOSAE*** Horvatič 1956

Alliance ***Deschampsion caespitosae*** Horvatič 1930

15. *Deschampsietum caespitosae* Hayek ex Horvatič 1930
16. *Caricetum brizoidis* O.Rațiu 1966

Class ***GALIO-URTICETEA*** Passarge 1967 em. Kopecký 1969

Order ***LAMIO ALBI-CHENOPODIETALIA BONI-HENRICI*** Kopecký 1969

Alliance ***Rumicion alpini* (Rübel 1933)** Klika 1944

17. *Urtico dioicae-Rumicetum alpini* (Șerbănescu 1939, Todor et Culică 1967) corr. Oltean et Dihoru 1986

The floristic surveys and grassland classification were carried out according to the Braun-Blanquet phytosociological method (CRISTEA et al., 2004; DONIȚĂ et al., 1992). To evaluate the production of green fodder mass and pastoral value, the new method based on floristic surveys of grassland associations was used (MARUȘCA, 2019). The synthesis of productivity data of the associations was done at the phytosociological alliance level, which is quite similar to grassland habitats (GAETA, MOUNTFORD, 2008). Other data regarding the material and working method with reference to the Apuseni Mountains have been presented in numerous other works (MARUȘCA,.2021 a, b; MARUȘCA et al. 2021; MARUȘCA et al.2022, a, b; MARUȘCA et al. 2023; PĂCURAR et al. 2023; PĂȘCUȚ, MARUȘCA, 2020). Finally, milk production per hectare is presented based on a conversion index resulting from long-term experiments with dairy cows (MARUȘCA et al. 2018, MARUȘCA, 2022).

RESULTS AND DISCUSSIONS

The 17 grassland associations are included in 11 alliances, 9 orders and 6 vegetation classes, highlighting a very high diversity. The 159 grassland floristic surveys were encountered between 532 m and 1837 m altitude on all exposures with an average slope of 6 degrees (Table 1). In the 17 associations identified in the area, an average of 57 cormophyte species were determined. The associations *Festuco rubrae-Agrostetum capillaris* (123 sp.), *Violo declinatae-Nardetum* (104 sp.) and *Festuco rubrae-Nardetum strictae* (81 sp.) were richer in species and the poorest were *Potentilletum reptantis* (27 sp.), *Potentillo-Festucetum ovinae* (33 sp.) and *Festucetum pictae* (33 sp.) which has only 43% coverage with vegetation located on the rocks.

Table 1

Overview of grassland associations in the Crișul Repede upper basin

No.	Grassland association	Survey (no.)	Altitude (m)	Exposition	Slope (degrees)	Cormophyte (no.)	Covering %
Al. ***Festucion pictae***							
1	*Festucetum pictae*	8	1560 (1427-1652)	N, S, W, E, NW, NE	52 (18-90)	33	43
*Al.****Loiseleurio-Vaccinion***							
2	*Cetrario-Vaccinietum gaultherioidis*	15	1760 (1725-1837)	E, W, N, S, NE, SW, PLAN	15 (0-36)	38	82
Al. ***Potentillo-Nardion***							
3	*Festuco rubrae-Nardetum strictae*	14	1475 (1000-1759)	PLAN, N, W, SW, S, NE	6 (0-26)	81	91
4	*Violo declinatae-Nardetum*	4	1430 (937-1832)	PLAN, N, NE, E, NW, SE, S, SW	7 (0-28)	104	98
5	*Potentillo-Festucetum ovinae*	5	1810 (1787-1836)	PLAN, W, NW	1 (0-6)	33	83
Al. ***Genistion pillosae***							
6	*Vaccinio-Callunetum vulgaris*	6	1065 (1051-1096)	S, SE, W, E	12 (2-28)	48	100
*Al.****Calamagrostion villosae***							
7	*Phleo alpini-Deschampsietum caespitosae*	8	1580 (1389-1694)	PLAN, N, W, S	4 (2-12)	52	86
Al. ***Molinion caerulae***							
8	*Junco-Molinietum*	5	1100 (604-1413)	PLAN	0	57	84
Al. ***Cynosurion***							
9	*Festuco rubrae-Agrostetum capillaris*	14	1200 (686-1731)	PLAN, W, NW, N, S, SE, SW	7 (0-20)	123	97
Al. ***Potentillion anserinae***							
10	*Potentilletum anserinae*	6	540 (532-548)	PLAN	0	33	81
11	*Ranunculetum repentis*	5	570 (540-686)	PLAN	0	45	86
12	*Potentilletum reptantis*	6	540 (532-548)	PLAN	0	27	78
Al. ***Juncenenion effusi***							
13	*Juncetum effusi*	11	1190 (544-1606)	PLAN, E, SE	1 (0-6)	75	93
14	*Agrostetum caninae*	5	560 (532-570)	PLAN	0	47	96
Al. ***Deschampsion caespitosae***							
15	*Deschampsietum caespitisae*	11	1480 (1130-1713)	PLAN	0	54	91
16	*Caricetum brizoidis*	6	1035 (654-1415)	PLAN	0	71	95
Al. Rumicion alpini							
17	*Urtico dioicae-Rumicetum alpini*	7	1350 (961-1547)	PLAN	0	40	96
AVERAGE - TOTAL		**159**	**1170 (532-1837)**	**ALL**	**6 (0-90)**	**57**	**87**

Of the average coverage of 87%, species with fodder value participate with only 24% and harmful ones 63%, which determines low productivity values in most of the grassland associations studied (Table 2). The highest participations of 88-89% of species with forage value were found in the associations *Festuco rubra - Agrostetum capillaris* and *Agrostetum caninae* and the highest participations of 91-93% of harmful species in *Vaccinio - Callunetum vulgaris*, and *Caricetum brizoidis.* The average pastoral value at the association level is quite low, having an index of 15.74, with large differences between the best associations which are *Festuco rubrae - Agrostetum capillaris* (67.3) and *Agrostetum caninae* (59.1) and the lowest *Cetrario - Vaccinietum gaultherioidis* (1.01) and *Caricetum brizoidis* (1.33).

The production of green fodder mass and the pastoral value are directly proportional to the degree of participation of fodder species in the grassy carpet. On average for the 17 associations studied, the participation of forage species is 24%, and of harmful species 63%, which ensures a pastoral value of 15.74 (poor), a production of 2.48 t/ha and a load of 0.34 LU/ha in 120 days of grazing season. The pastoral value indices are extremely heterogeneous, starting with 1 (degraded) in the *Cetrario - Vaccinietum gaultherioidis* association to 67.3 (good) in *Festuco rubrae - Agrostetum capillaris*. Similarly, the production of green fodder varies between 0.12 t/ha which can ensure 0.02 LU/ha in 80 days of grazing, up to 13.3 t/ha with 1.7 LU/ha in 120 days of grazing, exactly in the same associations above.

Table 2

Forage structure, pastoral value, green mass production and optimal animal loading

No.	Grassland association	Species structure (%)		Pastoral value		Green mass production t/ha	Grazing season (days)	Animal loading LU/ha
		Forager	Harmful	Ind.	%			
				Al. ***Festucion pictae***				
1	*Festucetum pictae*	38	5	21.22	135	2.30	95	0.37
				Al. ***Loiseleurio-Vaccinion***				
2	*Cetrario-Vaccinietum gaultherioidis*	2	80	1.01	6	0.12	80	0.02
				Al. ***Potentillo-Nardion***				
3	*Festuco rubrae-Nardetum strictae*	47	44	35.93	228	6.30	100	0.96
4	*Violo declinatae-Nardetum*	10	88	6.10	39	0.66	105	0.10
5	*Potentillo-Festucetum ovinae*	58	25	31.58	201	4.97	75	1.02
				Al. ***Genistion pillosae***				
6	*Vaccinio-Callunetum vulgaris*	9	91	4.87	31	0.53	135	0.06
				Al. ***Calamagrostion villosae***				
7	*Phleo alpini-Deschampsietum caespitisae*	20	66	13.64	87	1.26	90	0.22

No.	Grassland association	Species structure (%)		Pastoral value		Green mass production	Grazing season	Animal loading
Al. ***Molinion caeruleae***								
8	*Junco-Molinietum*	2	82	1.26	8	0.18	130	0.02
Al. ***Cynosurion***								
9	*Festuco rubrae - Agrostetum capillaris*	88	9	67.28	427	13.29	120	1.70
Al. ***Potentillion anserinae***								
10	*Potentilletum anserinae*	9	72	5.57	35	0.67	170	0.06
11	*Ranunculetum repentis*	5	81	3.53	22	0.54	165	0.05
12	*Potentilletum reptantis*	7	71	3.68	23	0.59	170	0.05
Al. ***Juncenion effusi***								
13	*Juncetum effusi*	6	87	3.83	24	0.53	120	0.07
14	*Agrostetum caninae*	89	7	59.10	375	9.10	165	0.85
Al. ***Deschampsion caespitosae***								
15	*Deschampsietum caespitosae*	5	86	3.20	20	0.39	100	0.06
16	*Caricetum brizoidis*	2	93	1.33	8	0.17	125	0.02
Al. ***Rumicion alpini***								
17	*Urtico dioicae-Rumicetum alpini*	7	89	4.49	29	0.63	110	0.09
AVERAGE		**24**	**63**	**15.74**	**100**	**2.48**	**120**	**0.34**

A more important analysis of grassland productivity was carried out at the geobotanical alliance level which is assimilated to the European-level habitat used for comparison (Table 3). The highest productivity was evaluated in the alliances *Cynosurion*, *Juncenion effusi* and *Potentillo-Nardion*, with an average of 7.36 t/ha, a load of 0.95 LU/ha, a pastoral value of 41.1 which can ensure 3,040 liters of cow's milk per hectare in 120 days of optimal grazing season. The most valuable alliance is *Cynosurion* with 13.3 t/ha of green fodder mass which allows 1.7 LU/ha in 120 days of grazing, at a pastoral value of 67.3 which ensures almost 5,000 liters of milk per hectare. At the opposite pole are the remaining 8 alliances where an average of 740 kg/ha of green fodder mass was evaluated, 10 times lower than in the first 3 alliances, a load of barely 0.11 LU/ha, a pastoral value of 6.6 which ensures 440 liters of milk in 110 days of grazing season, economic indicators that reach 12-16% compared to the best alliances (habitats) taken into analysis.

Table 3

Evaluation of cow milk production of the Crișul Repede upper basin grasslands

Alliance (Habitat)	Average altitude (m)	Green mass production (t/ha)	Grazing season (days)	Animal loading (LU/ha)	Pastoral value (ind.)	Milk production (l/ha)
A. The most productive phytosociological alliances						
Cynosurion	1200	13.29	120	1.70	67.3	4980
Juncenenion effusi	875	4.82	140	0.46	31.5	2710
Potentillo-Nardion	1570	3.98	95	0.69	24.5	1445
Average A	**1215**	**7.36**	**120**	**0.95**	**41.1**	**3040**
B. The least productive phytosociological alliances						
Loiseleurio-Vaccinion	1760	0.12	80	0.02	1.0	50

Alliance (Habitat)		Average altitude (m)	Green mass production (t/ha)	Grazing season (days)	Animal loading (LU/ha)	Pastoral value (ind.)	Milk production (l/ha)
Molinion caerulae		1100	0.18	130	0.02	1.3	105
Deschampsion caespitosae		1260	0.28	110	0.04	2.3	155
Genistion pillosae		1065	0.53	135	0.06	4.9	405
Potentillion anserinae		550	0.60	170	0.05	4.3	450
Rumicion alpini		1350	0.63	110	0.09	4.5	300
Calamagrostion villosae		1580	1.26	90	0.22	13.6	760
Festucion pictae		1560	2.30	95	0.37	21.2	1250
Average B		**1270**	**0.74**	**110**	**0.11**	**6.6**	**440**
Difference B-A	**+,-**	**+55**	**-6.62**	**-10**	**-0.84**	**-34.5**	**-2600**
	%	**105**	**10**	**92**	**12**	**16**	**14**

These data on the productivity of phytosociological alliances play an essential role in the preparation of pastoral arrangements and in the continued optimal management of permanent grasslands.

CONCLUSIONS

The permanent grasslands in the Crișului Repede upper basin, represented by 17 associations and 11 phytosociological alliances, located between 532 - 1837 m altitude, have a fairly high biodiversity through the 57 cormophyte species on average per association. The highest productivity was evaluated in the *Cynosurion* alliance (habitat) with 13.3 t/ha of green fodder mass, which allows a load of 1.7 LU/ha in 120 days of grazing season and achieves a pastoral value of 67.3 with almost 5000 liters of milk per hectare. The lowest productivity was evaluated in several degraded practical alliances such as *Molinion caerulae, Deschampsion caespitosae, Rumicion alpini* with 180 - 630 kg/ha green mass, loading 0.02 - 0.09 LU/ha, pastoral value 1.3 - 4.5 which can provide only 100 - 300 liters of milk per hectare.

REFERENCES

1. Cristea V., Gafta D., Pedrotti F., 2004, Fitosociologie, Editura Presa Universitară Clujeană.
2. Doniță N., Ivan Doina, Coldea Gh., Sanda V., Popescu A., Chifu Th., Paucă-Comănescu Mihaela, Mititelu D., Boșcaiu N., Davidescu G., Fodor Ecaterina, Gafta D., Lupașcu G.,Pop Adriana, Vițalariu G., 1992, Vegetația României, Ed. Tehnică Agricolă București.
3. Gafta D., Mountford J.O., - Coord., 2008 - Manual de interpretare a habitatelor Natura 2000 din România, Ed. Risoprint, Cluj Napoca.
4. Marușca T., Blaj V. A., Mocanu V., Andreoiu Andreea C., Zevedei P. M., 2018, Long term influence of botanical composition of alpine

pastures on cow milk production, Proceedings of the 27th General Meeting of the European Grassland Federation, EGF, Volume 23, Pp. 283-285, Cork, Ireland, 17-21 iunie, ISBN 978-1-84170-643-6.

5. Marușca T., 2019, Contributions to the evaluation of pasture productivity using the floristic releve, Romanian Journal of Grassland and Forage Crops Nr. 19, Cluj – Napoca, pp. 33- 47, ISSN 2068-3065.
6. Maruşca T., 2021a, Contributions to the assessment of Natura 2000 Habitat productivity of mountain pastures in Padurea Craiului (Southern-Eastern Carpathians), Romanian Journal of Grassland and Forage Crops, Cluj Napoca, nr.23 pp. 99-104, ISSN 2068-3065.
7. Marușca T.,2021b, Contribuții la evaluarea productivității ecologice a pajiștilor din Masivul Vlădeasa (Munții Apuseni), ASAS București, Acta Agricola Romanica, Seria Cultura plantelor de câmp, Tom.3, nr.3, pp.38-44.
8. Marușca T., Păcurar F., Scrob N., Vaida Ioana, Nicola Nicoleta, Taulescu Elena, Dragoş Marcela, Lukács Zs., 2021, Contributions to the assessment of grasslands productivity of the Apuseni Natural Park (ROSCI 0002) Romanian Journal of Grassland and Forage Crops, 24, 23.
9. Marușca T. 2022, Praticultură și pastoralism în cercetarea științifică, Editura Universității Transilvania din Brașov, 311 pagini, ISBN 978-606-19-1565-1.
10. Maruşca, T., Păcurar F. S., Taulescu Elena, Vaida Ioana, Nicola Nicoleta, Scrob N., Dragoș M. Marcela, 2022 a, Indicative species for the agrochemical properties of mountain grasslands soil from the Apuseni Natural Park (ROSCI 0002), Romanian Journal of Grassland and Forage Crops, Cluj Napoca, nr.25, pp. 31-40, ISSN 2068-3065.
11. Marușca T., Togor G.C., Dragoș M. Marcela, Comșia C. Cristina, 2022 b, Contribuții la evaluarea productivității pajiştilor din partea nordică a Munților Bihor, Journal of Montology (Jurnalul de Montanologie), CE-MONT, vol. 17 al, pag. 7-13.
12. Păcurar Fl. Marușca T., Scrob N., Vaida Ioana, Nicola Nicoleta, 2023, The ecologica land agronomic study of some grasslands phytocenoses from the Site Natura 2000 ROSCI 0002 Apuseni, Romanian Journal of Grassland and Forage Crops, Cluj Napoca, nr.28 pp. 31-54, ISSN 2068-3065.
13. Pășcuț C. Gh., Marușca T., 2020, Studies regarding the evolution of grassland productivity from Codru Moma Mountains (Western Carpathians), Annals of the Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences ISSN Online 2344-2085 Volume 9, Number 2/2020.

ASSESSMENT OF FORAGE QUALITY OF LEAVES OF TREES AND SHRUBS, WIDESPREAD IN AGROSILVOPASTORAL SYSTEMS IN DOBROGEA

Teodor MARUȘCA*, ANDREOIU Andreea C. *, Elena **, TAULESCU Elena MIHĂILĂ*, MEMEDEMIN Daniyar *, TÎBÎRNAC Marcel ***

** Research - Development Institute for Grasslands Brașov*
*** University Transilvania Brasov*
**** National Forestry Research-Development Institute (INCDS) „Marin Drăcea”*
**** ***maruscat@yahoo.com

Abstract

Climate change with the global warming that generates it, produces profound changes in the grass carpet of permanent grasslands, until their temporary drying in the summer months. Animals lacking green fodder consume leaves of shrubs and tree saplings, whose fodder quality is less known, which is why this study was done. The highest crude protein content of 24.2-24.7% was obtained in the leaves of Quercus pubescens and Robinia pseudoacacia and the lowest, 12.4% in Fraximus ornus.
Crude fiber content was very low, below 4%, in the leaves of Crataegus monogyna, Rosa canina and Cornus mas. The dry matter digestibility coefficient of over 85% was obtained in the leaves of the woody species: Quercus pubescens, Ulmus campestre and Cornus mas. The consumption of leaves and shoots of these woody species by animals prevents their establishment and uncontrolled expansion to the detriment of the grass carpet in agrosilvopastoral systems.

Keywords: woody species, fodder quality leaves, dry matter digestibility, Cluster analysis

INTRODUCTION

In the current conditions of climate change, agrosilvopastoral systems prevent the negative effects of global warming on grassland grass and livestock during the grazing season.

In countries with a hotter and drier climate around the Mediterranean Sea, in mid-summer, grassland production is greatly diminished and of low fodder value.

In this limiting situation, animals mainly consume the leaves of some woody species, which do not dry out (PEREVOLOTSKY et al., 1998; RABABAH et al., 2008).

Similar climate conditions are currently found in Dobrogea, Moldova, Transylvania and other hilly and plain areas in the south of our country, where animals frequently consume leaves and twigs of various woody species.

Research on the fodder quality of these fodder resources is less in our country, studies on the species *Sarothamnus scoparius*, introduced to us for hunting purposes (MARUȘCA și colab., 1999).

Likewise, in conditions of fodder crisis, due to prolonged droughts in our country, the so-called foliage of different trees and shrubs was frequently used to save animals during the cold season (PUȘCARU și DINU, 1968, cited by MARUȘCA, 2001).

During the field trips, from the dry summers of 2023-2024, in Dobrogea, it was found that the grassy carpet of the pastures was almost completely dry and the animals also consumed the leaves of shrubs and tree saplings.

The present work makes a first analysis of the forage quality of the leaves, as an additional resource in animal feed during the grazing season.

MATERIAL AND METHOD

The researches were carried out in the summer of 2023 and 2024, in the area of Dobrogea, in Tulcea county, where the state of almost complete drying of the grassy carpet of the pastures was found.

From 6 localities of Tulcea county, marked on the map (Figure 1), a number of 12 samples of leaves, consumed by animals, were taken from different trees and shrubs (Table 1), in the order of their distribution.

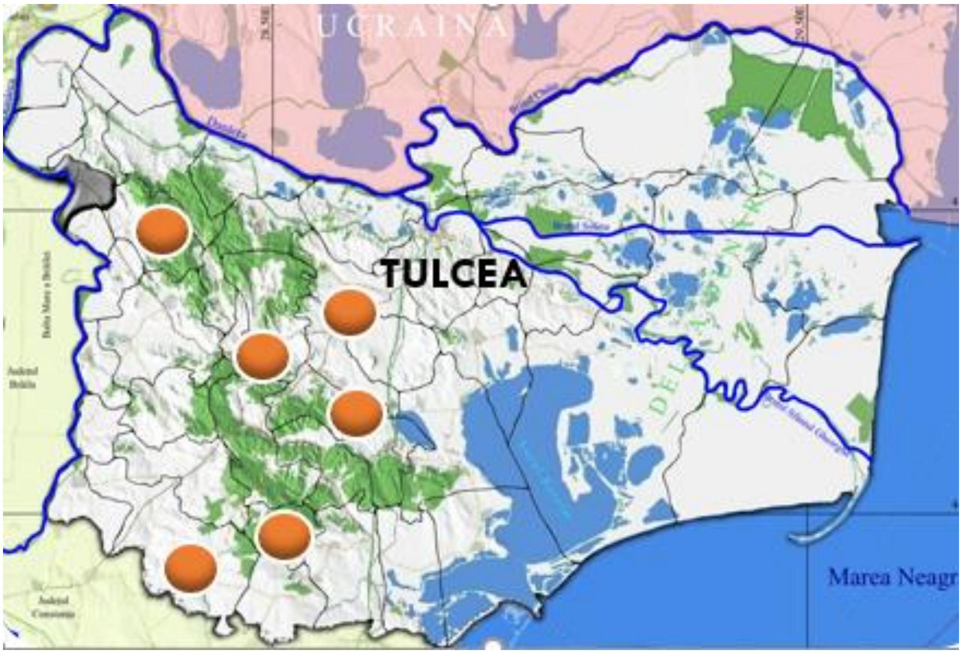


Fig. 1. Location of the localities where the leaf samples were taken

Table 1

Samples of leaves of shrubs and trees, from Tulcea county

No.	Sample leaves	*Acronym*	Location
1	*Crataegus monogyna*	*Cr. mon*	Altân Tepe
2	*Rosa canina*	*Rosa*	Greci
3	*Cornus mas*	*Co. mas*	Stejaru
4	*Carpinus orientalis*	*Ca. ori*	Altân Tepe
5	*Quercus pubescens*	*Q. pub*	Turda
6	*Quercus pedunculiflora*	*Q. ped*	Stejaru
7	*Pyrus pyraster*	*P. pyr*	Stejaru
8	*Tilia cordata*	*T. cor*	Altân Tepe
9	*Fraximus ornus*	*F. orn*	Altân Tepe
10	*Acer campestre*	*A.cam*	Stejaru
11	*Ulmus campestris*	*U. cam*	Stejaru
12	*Robinia pseudoacacia*	*R. pse*	Mihai Bravu

The 12 leaf samples were previously air-dried, after were dried in a forced convection oven type Memmert, at a temperature of 60°C to constant weight and were ground with a Grindomix GM 200 mill and prepared for analysis.

The following qualitative parameters were determined: crude protein (CP), ash (ASH), crude fiber (CF), acid detergent fiber (ADF), lignin (ADL), neutral detergent fiber (NDF), by the Near Infrared Spectroscopy technique, this has been widely used in many research areas because it is a rapid, simple and nondestructive technique (VIDICAN et al., 2000).

Principal Component Analysis (PCA) was also used for the interpretation of several data sets, being a technique to reduce the dimensionality of such data sets, increasing the interpretability, but at the same time minimizing the loss of information (IAN, 2005).

Another statistical processing method used was the Cluster analysis, regarding the similarity between the obtained data and the Euclidean distance was used.

RESULTS AND DISCUSSIONS

Following the analyzes performed, Table 2 presents the values of the main qualitative parameters analyzed, for the 12 samples of leaves from trees and shrubs. Regarding the crude protein content, the highest values were obtained in *Quercus pubescens* and *Robinia pseudocacia* leaves, 24.5% and 24.2%, respectively.

High values of the crude protein content were also recorded in the leaves of *Ulmus campestris* (19.7%) and *Crataegus monogyna* (19.4%).

The lowest value of the protein content was obtained in the leaves of *Fraximus ornus* (12.4%).

Table 2

The values of the main qualitative parameters analyzed for leaf samples of trees and shrubs

No.	Sample leaves	CP %	ASH %	CF %	ADF %	ADL %	NDF %	DDM %	DOM %
1	*Crataegus monogyna*	19,4	11,5	3,2	8,8	3,6	16,4	82,7	73,3
2	*Rosa canina*	15,0	10,9	1,9	6,3	0	19,4	84,6	67,9
3	*Cornus mas*	17,8	9,7	3,2	5,7	0,7	19,0	94,2	79,0
4	*Carpinus orientalis*	14,9	11,6	10,6	14,6	2,1	25,8	82,7	65,9
5	*Quercus pubescens*	24,7	13,2	10,8	15,5	3,3	29,4	85,3	76,8
6	*Quercus pedunculiflora*	18,2	11,5	15,7	18,9	2,8	33,2	76,9	66,9
7	*Pyrus pyraster*	16,7	9,8	11,0	15,4	3,9	28,8	75,2	70,4
8	*Tilia cordata*	16,9	11,5	17,0	20,4	3,1	33,4	72,3	61,2
9	*Fraximus ornus*	12,4	9,1	23,4	26,1	5,1	38,8	62,6	49,2
10	*Acer campestre*	14,2	12,0	9,3	13,0	1,0	24,6	74,8	52,3
11	*Ulmus campestris*	19,7	12,7	9,1	14,1	2,8	24,4	86,9	78,3
12	*Robinia pseudoacacia*	24,2	16,9	5,7	12,3	2,1	17,0	82,4	67,4

Regarding the total content in mineral elements (crude ash), the highest value was obtained in the leaves of acacia *Robinia pseudococacia*, (16.9%), and the lowest content was obtained in the mojdrean *Fraximus ornus* (9.1%).

The crude fiber content was very low, below 4%, in the leaves of *Crataegus monogyna*, *Rosa canina* and *Cornus mas*. The highest crude fiber content was obtained in the leaves of *Fraximus ornus* 23.4%.

The digestibility coefficient of the dry matter had values above 85% in the leaves of *Cornus mas*, *Querques pubescens* and *Ulmus campestris*. The lowest value of DDM 62.6% was obtained in the leaves of *Franximus ornus*, which also recorded the lowest protein content.

PCA (Principal Component Analysis) was used by applying the Kaiser criteria.

The eigenvalues and eigenvectors were extracted from the correlation matrix and thus, the number of significant factors and the percentage of variance explained by each of them was calculated.

The slope of the graph curve showed that the weight with the highest (82.6403%) part of the variation was explained by the first two components PC1 and PC2 (Figure 2).

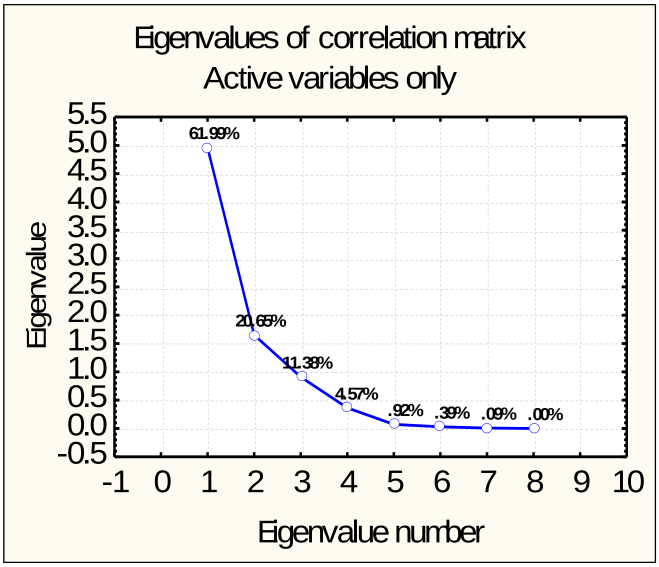


Fig. 2. The contribution of the main components and own values represented in descending order

Following Principal Component Analysis (PCA), 8 Components were obtained, listed in descending order in Table 4.

The first two components were selected applying the Kaiser rule (KAISER, 1960) and accounted for 82.6403% of the total variance (Table 4).

Table 4

Contribution of principal components (PCA) and the variables coefficients

Principal component	Eigenvalue	% Total variance	Cumulative Eigenvalue	Cumulative %
1	4.959234	61.99043	4.959234	61.9904
2	1.651987	20.64983	6.611221	82.6403
3	0.910649	11.38311	7.521870	94.0234
4	0.365467	4.56834	7.887338	98.5917
5	0.073874	0.92342	7.961211	99.5151
6	0.031104	0.38881	7.992316	99.9039
7	0.007459	0.09324	7.999775	99.9972
8	0.000225	0.00282	8.000000	100.0000

The first main component represented 61.9904%, and the second component represented 20.64983% of the total variance.

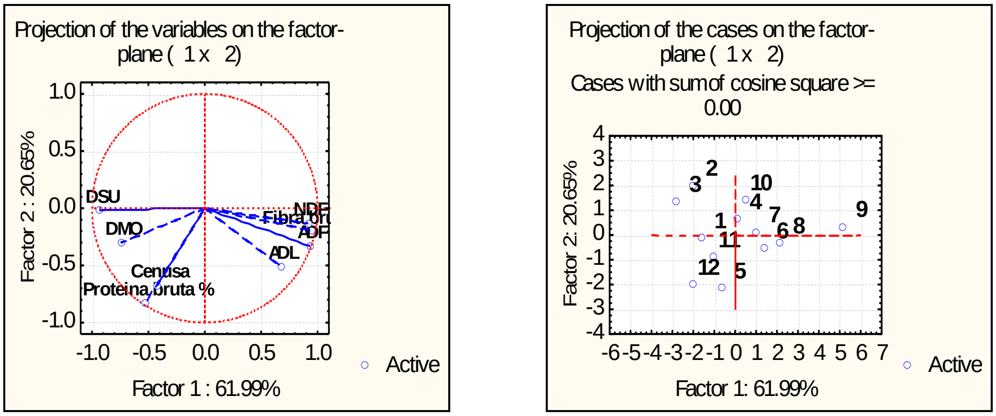
In Table 5, the coefficients of the variables that form PC 1 and PC 2 are presented, and the projection of the variables is shown in the Figure 3. Thus, PC 1 includes: Crude fiber (0.956), ADF (0.933), NDF (0.916) and ADL (0.677), which correlated positively with the first component and DDM (-0.929) and DOM (-0.745), which were negatively correlated with the first component, and the second main component was represented by crude protein (-0.827) and crude ash (-0.674).

Analysis of the main components, projection of variables in the main components (PC1 and PC2) are represented in Figure 3 and the coordinates of the variable factors, based on the correlations are presented in Table 5.

Table 5

Contribution of evaluated variables, based on correlations

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
CP	-0.531	-0.827	0.026	-0.034	-0.170	0.054	0.014	0.002
ASH	-0.422	-0.674	-0.594	-0.053	0.100	-0.048	-0.017	-0.003
CF	0.956	-0.202	0.048	-0.188	0.056	0.051	0.045	-0.008
ADF	0.933	-0.330	-0.014	-0.111	0.082	-0.005	0.015	0.012
ADL	0.677	-0.508	0.338	0.405	0.057	0.025	-0.026	-0.002
NDF	0.916	-0.128	0.190	-0.313	-0.079	-0.039	-0.052	-0.002
DSU	-0.929	-0.019	0.259	-0.213	0.117	0.102	-0.028	0.001
DMO	-0.745	-0.298	0.580	-0.078	0.047	-0.103	0.023	-0.001



1. Crataegus monogyna, 2. Rosa canina, 3. Cornus mas, 4. Carpinus orientalis, 5. Quercus pubescens, 6. Quercus pedunculiflora, 7. Pyrus pyraster, 8. Tilia cordata, 9. Fraximus ornus, 10. Acer campestre, 11. Ulmus campestris, 12. Robinia pseudoacacia

Fig. 3. a) Projection of variables in the main components (PC1 and PC2), and b. Projection of cases on the factor-plane

Cluster analysis was applied regarding the similarity, from the point of view of the qualitative parameters analyzed for the leaf samples, and from Figure 4 the grouping of three clusters is noted. The first cluster comprises the leaves of *Crataegus monogyna*, *Rosa canina* and *Robinia pesudocacia*.

The second cluster consists of the leaves of *Querqus pubescens* and *Ulmus campestris*, and the third cluster regarding the similarity, in terms of qualitative parameters, includes the leaves of: *Carpinus orientalis*, *Querqus peduculiflora*, *Tilia cordata* and *Pyrus pyraster*.

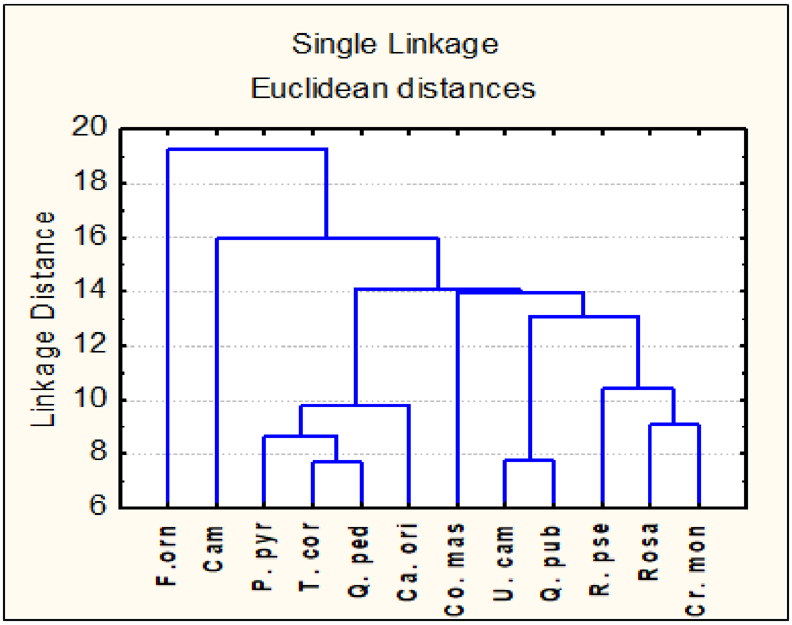


Fig. 4. Cluster analysis regarding the similarity, from the point of view of the qualitative parameters analyzed for the leaf samples

CONCLUSIONS

The highest values of crude protein content were obtained from Quercus pubescens leaves and *Robinia pseudoacacia*, 24,7%, respectively 24,2%.

The lowest value of the protein content was obtained in the leaves of *Fraximus ornus* (12,4%).

Crude fiber content was very low, below 4%, in *Crataegus monogyna* leaves, *Rosa canina* and *Cornus mas*.

The digestibility coefficient of the dry matter had values above 85% for *Cornus mas* leaves, *Querques pubescens* and *Ulmus campestris*.

REFERENCES

1. Ian J. (2005) Principal Component Analysis, John Wiley and Sons, Ltd., Aberdeen, UK.
2. Kaiser H. F. (1960) The application of electronic computers to factor analysis, Educational and Psychological Measurement, 20, 141-151.
3. Marușca T. (2001) Nutriția animalelor (Curs), Universitatea Transilvania din Brașov.
4. Marușca T., Capsa I., Dincă L. C. (1999) Spread and importance of common broom (*Sarothamnus scoparius* L. Wimm et Koch) in Rumanian grasslands, Grasslands and Woody Plants in Europe, Grassland Science in Europe, Vol. 4.
5. Perevolotsky A., Landau S., Kababia D., Ungar E. D. (1998) Diet selection in dairy goats grazing woody Mediterranean rangeland, Applied Animal Behaviour Science, Volume 57, Issues 1–2.
6. Rababah, T.M., Ereifej, K.I., AI-Mahasneh, M.A., Alhnmad M-N., Alrababah, M.A., Mukammad, A. H. (2008) The physicochemical composition of acorns for two mediterranean *Quecues species*. Jordan Jurnal Agricultural Science, 4 (2): 131-137.
7. Vidican R., Rotar I., Sima N. (2000) Tehnica NIRS (Near Infrared Reflectance Spectroscopy) si aplicaţiile sale în analiza calităţii furajelor. impozion "Agricultura si alimentaţia", USAMV Cluj Napoca, 187–191.

FOODER CROPS AND CLIMATE CHANGE

Anca PLEȘA, Florin PĂCURAR, Ioan ROTAR, Ioana GHEȚE

***Faculty of Agriculture. Department of Plant Crops. University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Manăștur street, 3-5, 400372, Romania.**
[*] Corresponding author, e-mail: florin.pacurar@usamvcluj.ro

Review

Abstract
Fodder crops are valuable agricultural due to the high dry matter yield they achieve but equally the quality of the fodder obtained. The global distribution of grasslands is determined by climate, primarily temperature and precipitation, which prevent the formation of forests or deserts but also some researchers affirm that grassland reduces the risk of illnesses. Climate change is an imminent threat to the world we live in, but we can all do something to combat it and build a better future. The change in the general character of the objectives for agriculture, from a priority for production towards an increased concern for environment is consistent with more general trends that occur with economic development. Finding the best solutions for feeding humanity with a rethinking of actions regarding environmental consequences is urgently needed. Therefore, global population growth, degradation and reduction of agricultural land areas, climate change accompanied by acute and long-term droughts, imperatively require the mobilization of resources from different areas that can capitalize on new climate conditions while ensuring food security.

Keywords: fodder crop, temporary grassland, climate change

INTRODUCTION

Global food security threatened by climate change is one of the most important challenges in the 21st century to supply sufficient food for the increasing population while sustaining the already stressed environment (Kang *et al.*, 2009). Changes in both the mean and the variability of climate, whether naturally forced, or due to human activities, pose a threat to crop production globally (Slingo *et al.*, 2005). In a study conducted in 2011 by Havilah in Encyclopedia of Dairy Sciences (Second Edition) it is shown that annual forages and fodder crops are used worldwide as key feed sources for dairy systems and grasses, legumes, and brassicas either sown alone or in mixtures are used as annual forages. Reddy *et al*, 2003, in other study, shows that pastures (herbaceous plants, fodder trees/shrubs), crop residues, cultivated forages, concentrate feeds (agro-industrial by-products, grains, feed supplements, etc.) and household wastes are the main resources used as livestock feed.

Kumar *et al.*, 2022, said that fodder, also known as hay, silage, or forage, is any crop or crop by-product used as feed for livestock, making it an essential source of protein and fat. As well as yield, changes in crop quality can have a major impact on food systems and their vulnerability to climate variability and change (Slingo *et al.*, 2005).

GRASSLAND'S IMPORTANCE IN CLIMATE CHANGE

Agriculture and livestock farming are deeply interrelated in the cultural, religious, and economic ways of human society engaged with mixed farming and livestock rearing serving as important source of rural people (Dagar, 2017, Dhamodharan *et al*, 2024).

Petermann and Buzhdygan, 2021, said that ecosystem functioning and ecosystem services provided by grasslands are part of global feedback loops in which grassland biodiversity, human well-being and global change are linked.

Grassland ecosystems can constitute a source or a sink in the global C balance, and their management affects their position in that balance (Casals *et al.*, 2004).

In a study conducted in North Kazakhstan, Shayakhmetova *et al*, 2024 concluded that climate change has significantly impacted the phenology of fodder grasses. Excessive increases in temperature and a lack of moisture have stressed plants, leading to slower growth and consequently reduced biomass and productivity of fodder crops. They recommend combining crops more effectively in the developed green conveyor system ensures the collection of high-quality green mass despite the instability of climatic factors. Optimizing sowing and utilization times provides a stable and high-quality feed base for agricultural producers and farmers.

In another study in India, Kumar *et al.*, 2022, emphasizes the fact that livestock sector also plays a significant role in supplementing family incomes and generating gainful employment for rural poor, particularly among the landless labourers, small and marginal farmers and women. It also provides balanced and cheap nutritional food in the form of milk to millions of people.

Sagalbekov *et al.*, 2022 shows the fact that the improvement of productivity in modern livestock farming is directly dependent on feed production and the rational feeding of animals. However, further development of feed production is constrained by the low productivity of agricultural lands, the insufficiency of varieties adapted to specific soil and climatic zones, and the poor resilience of fodder crops to adverse environmental conditions (Nasiyevich, *et al.*, 2013). As well as yield, changes in crop quality can have a major impact on food systems and their vulnerability to climate variability and change (Porter and Semenov, 2005).

Agricultural systems that increase reliance on biodiversity can mitigate risks associated with climate change and should be considered a crucial component of the solution (Henry *et al.*, 2012).

CLIMATE CHANGE IMPACTS ON FOODER CROP

Shayakhmetova *et al*, 2024 affirm that ensuring global food security is one of the most serious challenges facing humanity in the 21st century due to ongoing climate change and rapid population growth. Global demand for food has been on the rise, driven by a growing population, rapid urbanization, and changing diet preferences (Hu *et al*, 2024). Understanding crop responses to climate change is crucial for ensuring food security.

In a Technical Report in August 2012, Grover and Kumar shows that for exploiting fully the production potential of livestock, balanced and adequate feeding is the most crucial. Other examples of the effects of climate on crop quality include pests and diseases, such as dangerous levels of mycotoxin. Relatively little is known about the potential impact of climate change on crop quality (Slingo *et al*., 2005).

In crop production, fodder is the end product, the quality of which significantly affects the livestock (Kumar *et al*., 2022). Paterson and Lima, 2011, declare that climate change will affect mycotoxins in food. The changes in the management and status of grasslands lead to a powerful variation of soil microbial communities' assemblage and functionality (Stoian et Vidican, 2024).

Hu *et al*, 2024 to demonstrate the impact of climate change in the study entitled *Climate change impacts on crop yields: A review of empirical findings, statistical crop models, and machine learning methods* reviewed 226 studies that used statistical models to characterize the impacts of climate change on crop yields. In these studies, the authors show the importance of field studies, because they emphasize that if not informed collectively by field experiments of all kinds, the implementation of process-based models for the digital twin is unlikely to be successful. Even so, in Figure 1 they highlighted the strengths and weaknesses of the 3 models they applied (scientific methods for investigating crop yield responses to climate change fall roughly into three categories: field experiments, process based modeling, and statistical modeling).

This could be a reason why Gobin *et al*, even from 2006 show that the management of monitoring and control of permanent pastures requires the creation of a comprehensive geoinformation platform that allows for spatio-temporal analysis to monitor changes, account for protective zones, keep record of abandoned pastures and establish sensitive zones.

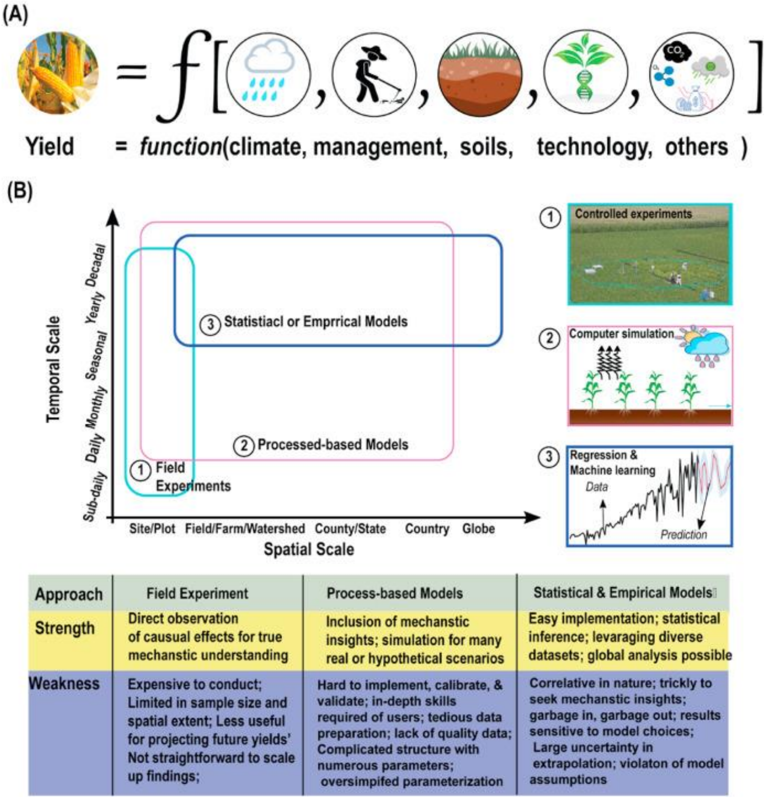


Fig. 1. (a) Crop yield as a function of multiple drivers. (b) Characteristics of three common approaches--field experiments, process-based, and empirical modeling--for evaluating climatic impacts on crop yield. These approaches are applied typically at contrasting spatial and temporal scales (i.e., colored boxes in the temporal-spatial scale plot), Source: Hu *et. al*, 2024

INSTEAD OF CONCLUSIONS…

The tensions caused by the substantial reduction of non-renewable natural resources, the threat to food security, amplified by global climate change, force us to react, according to the potential and resources we have, to find solutions, means and measures that must be taken, to prevent and mitigate the catastrophic effects that can occur when reckless measures are taken or to obtain profit at any cost (Hera, 2015). In this context, fodder crops are appreciated as necessary and particularly useful not only for specialists in the field, but also for those in related fields.

REFERENCES

1. Casals P., Garcia-Pausas J., Romanyà J., Camarero L., Sanz M.J. and Sebastià M.T.2004. Effects of livestock management on carbon stocks and fluxes in grassland ecosystems in the Pyrenees. Land Use Systems in Grassland Dominated Regions
2. Dagar JC. Potentials for fodder production in degraded lands. In: Ghosh PK, Mohanta SK, Singh JB, Vijay D, Kumar RV, Yadav VK. editors. Approaches towards fodder security in India. Studera Press New Delhi; c2017. p. 333–364.
3. Dhamodharan P, J Bhuvaneshwari, S Sowmiya and R Chinnadurai. 2024. Revitalizing fodder production: Challenges and opportunities. International Journal of Research in Agronomy 2024; 7(1): 208-217
4. Gobin B., L. Brodsky, B. Tychon, E. Andersen, P. Campling, J. Van Orshoven. 2006. Protection and maintenance of permanent pastures. Geographical Information in support of theCommon Agricultural Policy, Proceedings of the 12th MARS PAC Annual Conference, 2006
5. Henry, B.; Charmley, E.; Eckard, R.; Gaughan, J.B.; Hegarty, R. Livestock Production in a Changing Climate: Adaptation and Mitigation Research in Australia. Crop Pasture Sci. 2012, 63, 191–202
6. Hera Cristian. 2015. Terra-Planeta Albastră, Schimbări climatice globale, grija pentru resurse naturale, Editura Academiei Romane, București
7. Hu Tongxi, Xuesong Zhang, Sami Khanal, Robyn Wilson, Guoyong Leng, Elizabeth M. Toman, Xuhui Wang, Yang Li and Kaiguang Zhao. 2024. Climate change impacts on crop yields: A review of empirical findings, statistical crop models, and machine learning methods. Environmental Modelling & Software, Volume 179.
8. Kumar, P.; Singh, J.; Kaur, G.; Adunola, P.M.; Biswas, A.; Bazzer, S.; Kaur, H.; Kaur, I.; Kaur, H.; Sandhu, K.S.; et al. OMICS in Fodder

Crops: Applications, Challenges, and Prospects. Curr. Issues Mol. Biol. 2022, 44, 5440–5473. https://doi.org/10.3390/cimb44110369

9. Nasiyevich, N.B. The Role of Organic Fertilizers in Inceasing the Fertility of West Kazakhstan Soil. Pol. J. Soil Sci. 2013, 46, 115–124.
10. Paterson R.R.M. and N. Lima. 2011. Further mycotoxin effects from climate change. Food Research International, Vol. 44, Issue 9.
11. Petermann Jana S. and Oksana Y. Buzhdygan. 2021. Grassland biodiversity Current Biology 31, R1141–R1224, Elsevier Inc.
12. Porter, J. R. & Semenov, M. A. 2005 Crop responses to climatic variation. Phil. Trans. R. Soc. B 360, 2021–2035. (doi:10.1098/rstb.2005.1752.)
13. Reddy B.V.S, P Sanjana Reddy, F Bidinger, M Blümmel, 2003. Crop management factors influencing yield and quality of crop residues. Field Crops Research Volume 84, Issues 1–2, 2003, Pp. 57
14. Sagalbekov, U.M.; Baydalin, M.E.; Baydalina, S.E.; Achet, A.O.; Baiken, A.S. Results of Cultivation of Perennial Forage Grasses under Conditions of Northern Kazakhstan. Izdenister Natigeler 2022, 54–63.
15. Shayakhmetova, A.; Bakirov, A.; Savenkova, I.; Nasiyev, B.; Akhmetov, M.; Useinov, A.; Temirbulatova, A.; Zhanatalapov, N.; Bekkaliyev, A.; Mukanova, F.; et al. Optimization of Productivity of Fodder Crops with Green Conveyor System in the Context of Climate Instability in the North Kazakhstan Region. Sustainability 2024, 16, 9024. https://doi.org/10.3390/su16209024
16. Slingo Julia M., Andrew J. Challinor, Brian J. Hoskins and Timothy R. Wheeler. 2005. Introduction: food crops in a changing climate. Phil. Trans. R. Soc. B (2005) 360, 1983–1989. Doi:10.1098/rstb.2005.1755
17. Stoian Vlad și Vidican Roxana. 2024. Key concepts in the use of microorganism as indicators of grassland degradation. Romanian Journal of Grassland and Forage Crops (2024) 29.

IMPORTANCE OF VEGETATION SUCCESSION IN URBAN GRASSLANDS

Veronica SĂRĂȚEANU [1], Otilia COTUNA [1*], Daniela Sabina POȘTA[1*], Mirela PARASCHIVU [2*]

[1] *University of Life Sciences "King Mihai I" from Timişoara, Romania*
[2] *University of Craiova, Faculty of Agriculture and Horticulture, Romania*
**Corresponding authors: otiliacotuna@yahoo.com; posta.daniela@gmail.com; paraschivumirela@yahoo.com*

Abstract

Urban meadows have begun to become interesting for authorities in urban areas, including in our country, who are starting to support such landscaping solutions, not only for marginal areas but also for central areas of cities. Vegetation succession is an important phenomenon for restoring urban grassland vegetation as a functional habitat. Their importance consists in the setting of native species, the best adapted for the site conditions. Thus, succession is of great importance for obtaining sustainable and resilient urban grassland habitats able to provide environmental services for the human communities from their vicinity. Urban grasslands are exposed to the influence of natural and anthropogenic factors that are directing vegetation succession, having similarities with managed permanent grassland ecosystems. The anthropogenic factors implied in the appearance of the floristic composition of urban grasslands are usually mowing frequency, the addition of seeds, the removal of clipping, etc. Thus, the natural factors involved in the increase of the biodiversity in urban grassland canopy can be wind, birds, seed reserves in the soil etc.

Keywords: urban grassland, succession, functional landscape, resilient green space, urban natural habitat.

INTRODUCTION

The expansion of urban areas worldwide is associated with the increase of hard and paved areas with a serious impact on the natural fluxes. The most popular solution applied for the greening of urban areas is classical turf but with a high demand for energy and resources for maintenance (Ng *et al.*, 2015; Sărățeanu *et al.*, 2023).

According to Klaus (2013), urban grasslands are able to provide numerous services for our society as environmental, recreational, social and even financial. From the environmental services, the potential support of local biodiversity makes the urban grassland ecosystem proper for development and conservation.

Urban grassland parks are permanent green spaces, sometimes several decades old, that provide residents with recreational spaces. They are characterized by predominant grassy vegetation and scattered woody vegetation. The most important factor disturbing them is heavy traffic and frequent mowing. For this reason, they have very disturbed soil. In these parks, the vegetation is usually mowed several times a year (Sărățeanu *et al.*, 2023).

As an example, the diminishing mowing frequency determines the increase of biodiversity in a lawn, directing its evolution to an urban grassland (Sehrt et al., 2020) and being a driver for vegetation succession.

Periurban grasslands are habitats with a generally larger surface area compared to parks. They are located around built-up areas of cities, being old agricultural lands or abandoned industrial areas, in a medium successional stage. The age of the vegetation cover of these areas is characterized by spontaneous regeneration of vegetation. Such urban grasslands can be compared with semi-natural grasslands due to the role played in the preservation of biodiversity (Güler, 2020).

Fisher *et al*. (2012) have investigated the potential of wastelands and degraded soils with stones and brick content from urban areas in the development of low-maintenance urban grasslands rich in species. Thus, they have used regional seeds, adapted to the ecological conditions, with very good results. Their results proved the hypothesis, showing that rare grassland species can be persistent in such habitats, even in conditions with high rates of ruderal species. Also, the obtained urban grasslands were able to provide ecological services; but also provided recreational areas appreciated by the residents with psychological and social benefits. Thus, restoration of urban grasslands in wastelands and highly degraded urban land improves the urban landscape and environment.

Thus, the research developed by Ng *et al.* (2015) on the CO_2 rates of respiration were higher in turf than in grassland. Also, they have hypothesised that urbanisation and, implicitly, the increase in the turf area will influence the urban atmospheric CO_2 rates.

According to Hejkal *et al.* (2017), the connectivity of the urban grassland patches is very important for the self-sustaining of the habitat networks from urban areas. This theory has explored the functional connectivity between public urban grassland patches considering the patch size and distance between patches. In the same context, different plant species groups were investigated from the perspective of dispersal distance, respectively 2m, 20m, 44m and 100m. Thus, it was confirmed that the graph theory is a proper tool for analysing habitat connectivity.

Urban grasslands with high biodiversity can be used to educate the public regarding the importance of nature conservation by experiencing it personally. The access of the inhabitants from big cities to natural habitats is often limited. Thus, urban grasslands can be a great option for their experience with nature (Dresseno *et* Overbeck, 2013).

In Mediterranean countries could be difficult to implement the concept of urban grassland as an alternative to turf, but literature recommends lawn mixtures of grasses and legumes that shall be mown quite frequently and remove the clippings. The motivation is to reduce the risk of fire propagation (Monteiro, 2017).

The purpose of this work was to analyse the literature resources referring to the implications of the setting of resilient and functional urban grasslands from the perspective of the impact of the vegetation succession process.

Practically, this paper intends to present the data from the literature that emphasize the role of the natural process of vegetation succession in obtaining cheaper and easier sustainable and resilient green spaces inside the anthropic environment of the cities suffocated by hard surfaces. There is a high demand for environmental services in the urban environment, the grassland being one of the more convenient solutions in many situations of landscape design. Thus, the need for responsible management of the resources fits with the use of urban grasslands as an alternative to the classical turf. Such designs demand knowledge in grassland science, so landscapers should collaborate with specialists from this field to obtain the best results in creating functional and resilient urban grasslands.

DISCUSSIONS

Literature referring to the succession process involved in the establishment and evolution of urban grassland ecosystems is very poor; there are only a few documents in this field that are approaching this topic.

Urban grasslands can be assimilated with managed permanent grasslands from the perspective of vegetation cover composition, dominated by native plant species. In the urban area, they are most often the result of vegetation succession from old fields. Management of urban grasslands by mowing prevents, in general, the encroachment of shrubs and woody vegetation. The mechanical removal of shrubs and tumps can create patches of bare soil where occur annual weeds and even invasive species such as *Ambrosia artemisiifolia* (Greller *et al*., 2000).

Rudolph *et al.* (2016) show that species richness is influenced by the maintenance intensity of urban grasslands, such as frequent mowing. However, the habitat conditions in most of the studied areas had proper abiotic conditions for the existence of a greater number of species that can be introduced in different manners in the urban grassland habitat.

In research performed in Sweden, several methods of creating urban grasslands rich in meadow species were tested. The main conclusion was that long-term research is needed to look closer at the impact of natural factors and management on the urban grassland floristic composition (Mårtensson, 2017).

Research by Quintana *et al*. (2024) shows that urban habitats represent new opportunities to study natural processes such as vegetation succession. Thus, the research focused on the changes that occur during vegetation succession from the dominance of annual to perennial species in periurban green spaces in the Mediterranean area. The most important aspect highlighted was the fact that the soil had a significantly higher carbon content with the increase in the participation of perennial species in the vegetation cover. Thus, the research demonstrated that through the natural succession of the vegetation cover in green spaces, certain ecosystem services such as soil carbon storage, water regulation and nutrient cycling are improved.

A study developed over five years showed that seeding a mixture of species to cover well the soil surface can become rich in species and prevent the colonization of weeds due to the evolution of the floristic composition. The obtained prairie-like vegetation cover had a better appearance during the cold season and a pleasant spring flowering appearance (Hitchmough *et al*., 2017).

Research conducted in the Chicago metropolitan area demonstrated that green space areas in advanced successional stages, i.e. minimally maintained for at least 10 years, had a significantly higher soil organic carbon content compared to classically maintained green spaces (Yost *et al*., 2016).

In addition to enriching the soil with organic matter, vegetation succession contributes significantly to increasing biodiversity in urban areas, as most green spaces are in early successional stages, characterized by the presence of large numbers of both annual and perennial species (Niemelä, 1999).

Research that analysed different types of urban grasslands in historic centres of 32 European cities, from those in early succession to mid succession, from the perspective of factors influencing floristic composition, showed that variation in species composition is mainly influenced by habitat type (Lososova *et al*., 2012).

Deák *et al*. (2016) found that the mid-successional peri-urban grasslands have higher biodiversity compared to intensively managed urban grasslands from recreational sites. Thus, the vegetation from parks was dominated by early-successional species, while in peri-urban grasslands were dominant mi-successional species. Such successional urban grasslands can be restored by using local seeds from species with high adaptability to the urban environment and by applying proper management. Also, can be a potential pool of biodiversity for the restoration of other urban grasslands.

Creating urban grasslands on wasteland from urban areas needs personalized approaches considering the grassland and ornamental species seeded and specific low maintenance intensity as autumn and early spring mowing to reduce the competition with early weds. Setting a successful urban grassland requires time for the expression of the establishment of a resilient floristic composition (Köppler *et al*., 2014).

Rojas-Botero et al. (2023) highlight the role of the ecological filters of the urban site and the year conditions on the species diversity setting in the road verges from urban areas. This means that a mixture of species seeded for the restoration of biodiversity will be under the pressure of these filters that will eliminate some species and will favour other species over time, having as a result of the modification of the vegetation community structure.

Other approaches of urban grassland development, described the speed-up of grassland vegetation restoration by introducing propagules of native grassland species from hay or seeding a commercial mixture. The species composition obtained during the three years of the research was similar to a successional secondary grassland developed naturally for 30 years without any intervention (Kövendi-Jakó *et al*., 2018).

According to the results obtained by Jiang *et* Yuan (2023), climate evolution, e.g. rainfall regime is influencing the urban grassland diversity and stability. In this way, the increase in the rainfall amount can accelerate the succession process by highlighting the competitor strategy of the ruderal species, thereby affecting the stability and sustainability of the species community. Also, it is suggested that it is necessary to pay more attention to the implication of the succession process in the evolution of urban grassland vegetation.

In an experiment on six sown urban grasslands, Norton *et al*. (2019) found that mowing intensity has an important role in the evolution of colonization of spontaneous species, with colonizer species having a lower participation in the plots rich in species mown with low frequency. Also, the mowing has an impact on the microbial diversity and invertebrate fauna, these being richer in the tall vegetation in comparison with short-mown urban grassland. A suggestion was to alternate in a designed model the alternation tall vegetation with short mown vegetation as mosaics, to provide conditions for more species of plants, soil microorganisms and invertebrates.

The minimal mowing works applied in urban grasslands shall keep them in a resilient condition so as to prevent the continuation of the succession process to shrubland and woody vegetation, as is in the case of secondary agricultural grasslands, this kind of management proves to be the most effective for a rich biodiversity and a sustainable and functional vegetation community.

CONCLUSIONS

For the creation and management of urban grasslands, knowledge of vegetation succession is necessary because this natural phenomenon, together with the management of these areas, contributes to obtaining a stable and self-sustaining vegetation cover, similar to a natural habitat.

Some of the factors that accompany the processes of vegetation succession of urban grasslands, respectively their evolution, are represented by anthropogenic activities, but natural factors are also involved (wind, birds, seed reserves in the soil, etc.) as in the case of permanent grasslands.

The intensity of urban grassland management influences their appearance and functionality.

Urban grasslands act as permanent grasslands from the perspective of environmental services; but also, they are under the influence of the natural and anthropogenic factors that are directing the floristic composition, succession of the vegetation being one of those factors.

The strategies for establishing successful and functional urban grasslands shall have in view the use of seeding mixtures adapted to the local conditions and tolerant to the local environmental factors and low intensity mowing.

Acknowledgements

This work is realised with the support of the Monitoring Unit for Invasive Species from the University of Life Sciences ”King Mihai I” from Timişoara, Romania.

REFERENCES

1. Ng B., Hutyra L., Nguyen H., Cobb A., Kai F., Harvey C., Gandois L. (2015) Carbon fluxes from an urban tropical grassland. Environmental Pollution, 203, 227-234. https://doi.org/10.1016/j.envpol.2014.06.009.
2. Sărățeanu V., Cotuna O., Poșta D.S., Paraschivu M. (2023). Urban grassland - a biodiversity resource. Romanian Journal of Grasslands and Forage Crops, 28: 69-78.

3. Hejkal J., Buttschardt T.K., Klaus V.H. (2017) Connectivity of public urban grasslands: implications for grassland conservation and restoration in cities. Urban Ecosystems. 20: 511–519. https://doi.org/10.1007/s11252-016-0611-8.
4. Fischer L. K., Lippe M. V. D., Rillig M. C., Kowarik I. (2013) Creating novel urban grasslands by reintroducing native species in wasteland vegetation. Biological Conservation, 159: 119-126. https://doi.org/10.1016/j.biocon.2012.11.028.
5. Monteiro J. A. (2017) Ecosystem services from turfgrass landscapes. Urban Forestry & Urban Greening, 26: 151-157. https://doi.org/10.1016/j.ufug.2017.04.001.
6. Dresseno A.P., Overbeck G.E. (2013) Structure and composition of a grassland relict within an urban matrix: potential and challenges for conservation, Iheringia, Sér. Bot., Porto Alegre, 68 (1), p. 59-71.
7. Greller A.M., Durando C., Marcus L.F., Wijesundara D.S.A., Byer M.D., Cook R., Tanacredi J.T. (2000) Phytosociological analysis of restored and managed grassland habitat within an urban national park. Urban Ecosystems 4, 293–319 https://doi.org/10.1023/A:1015755832045.
8. Deák B., Hüse B., Tóthmérész B. (2016) Grassland vegetation in urban habitats–testing ecological theories. Tuexenia, 36, 379-393.
9. Sehrt M., Bossdorf O., Freitag M., Bucharova A. (2020) Less is more! Rapid increase in plant species richness after reduced mowing in urban grasslands, Basic and Applied Ecology, 42:47-53, https://doi.org/10.1016/j.baae.2019.10.008
10. Quintana, José Ramón and Fernández San Julián, Javier and González-Ubierna, Sergio and Casermeiro, Miguel Ángel and García-Torija, Miriam and López Alía, Teresa and Vázquez, Antonio and Molina, José Antonio (2024) Natural Succession in Grasslands Improves Most Ecosystem Functions in Mediterranean Urban Greenspaces. Available at SSRN: https://ssrn.com/abstract=4779204 or http://dx.doi.org/10.2139/ssrn.4779204.
11. Yost, J. L., Egerton-Warburton, L. M., Schreiner, K. M., Palmer, C. E., & Hartemink, A. E. (2016). Impact of Restoration and Management on Aggregation and Organic Carbon Accumulation in Urban Grasslands. Soil Science Society of America Journal, 80(4), 992-1002. https://doi.org/10.2136/sssaj2015.10.0383.
12. Niemelä J (1999) Is there a need for a theory of urban ecology? Urban Ecosyst 3(1):57–65. https://doi.org/10.1023/A:1009595932440.
13. Lososová Z., Chytrý M., Tichý L., Danihelka,J., Fajmon K., Hájek O., Kintrová K., Kühn I., Láníková D., Otýpková Z., Řehořek V. (2012):

Native and alien floras in urban habitats: a comparison across 32 cities of central Europe. Glob. Ecol. Biogeogr. 21: 545–555.
14. Güler, B. (2020). Plant species diversity and vegetation in urban grasslands depending on disturbance levels. Biologia 75, 1231–1240, https://doi.org/10.2478/s11756-020-00484-0.
15. Hitchmougha J., Wagner M., Ahmad H. (2017). Extended flowering and high weed resistance within two layer designed perennial "prairie-meadow" vegetation. Urban Forestry & Urban Greening, Volume 27, Pages 117-126, https://doi.org/10.1016/j.ufug.2017.06.022.
16. Mårtensson L.M., (2017). Methods of establishing species-rich meadow biotopes in urban areas. Ecological Engineering, 103:134–140, http://dx.doi.org/10.1016/j.ecoleng.2017.03.016.
17. Köppler M.R., Kowarik I., Kühn N., von der Lippe M. (2014). Enhancing wasteland vegetation by adding ornamentals: Opportunities and constraints for establishing steppe and prairie species on urban demolition sites, Landscape and Urban Planning, Volume 126, Pages 1-9, https://doi.org/10.1016/j.landurbplan.2014.03.001.
18. Rojas-Botero S., Dietzel S., Kollmann J., Teixeira L.H. (2023). Towards a functional understanding of rehabilitated urban road verge grasslands: Effects of planting year, site conditions, and landscape factors, Flora, Volume 309,152417, https://doi.org/10.1016/j.flora.2023.152417.
19. Kövendi-Jakó, A., Halassy, M., Csecserits, A., Hülber, K., Szitár, K., Wrbka, T., & Török, K. (2018). Three years of vegetation development worth 30 years of secondary succession in urban-industrial grassland restoration. Applied Vegetation Science, 22(1), 138-149. https://doi.org/10.1111/avsc.12410.
20. Jiang, Y., Yuan, T. (2023). The effects of precipitation change on urban meadows in different design models and substrates. Sci Rep 13, 20592 . https://doi.org/10.1038/s41598-023-44974-y.
21. Norton, B. A., Bending, G. D., Clark, R., Corstanje, R., Dunnett, N., Evans, K. L., Grafius, D. R., Gravestock, E., Grice, S. M., Harris, J. A., Hilton, S., Hoyle, H., Lim, E., Mercer, T. G., Pawlett, M., Pescott, O. L., Richards, J. P., Southon, G. E., & Warren, P. H. (2019). Urban meadows as an alternative to short mown grassland: Effects of composition and height on biodiversity. Ecological Applications, 29(6), e01946. https://doi.org/10.1002/eap.1946.

EFFECT OF 2022-2023 AGRICULTURAL YEAR CLIMATIC SPECIFIC CONDITIONS ON THE QUALITY OF THE SEED MATERIAL OF THE ANAMARIA SAINFOIN VARIETY

Mihai STAVARACHE*, DUMITRIU (Acatrinei) Simona, VACARCIUC (BĂDRĂGAN) Elena-Manuela, GAVRILĂ Cristian-Sorin

Research and Development Station for Meadows Vaslui, Romania
**Corresponding author e-mail: scdp_vs@yahoo.com*

Abstract

The research conducted during the period of March to October 2023, at the Research and Development Station for Meadows (RDSM) Vaslui (46°40'-36°10' north latitude and 27°44'-20°40' east longitude) followed the influence of climatic conditions specific to the area, on the seed production and quality of the seed material in *Onobrychis viciifolia* Scop. *species, Anamaria variety. This species has an important role in combating erosion and increasing the fertility of degraded soils. Seeds productions, germination parameters and seed index were analyzed at the seed material produced within the RDSM Vaslui in the 2020-2023 period. The results obtained showed that each of the main climatic elements, namely the temperature and precipitation, profoundly influenced the production of seed material and the analyzed parameters, being observed peculiarities out of the ordinary. The seeds from the Anamaria sainfoin variety, produced in 2023 had germination of only 55 %, 20 % less than the minimum value required by the Romanian legislation, so that the seeds can be certified.*

Keywords: seeds production, fertilization, germination, abnormal germs, dead seeds.

INTRODUCTION

Sainfoin (*Onobrychis viciifolia* Scop.) is a perennial legume that exhibits a number of particularly valuable biological qualities, such as remarkable resistance to drought and frost, and both to diseases and pests. At the same time, it effectively harnesses soils with a more modest fertility potential and has an important role in combating soil erosion on the slope (Frame J. *et al*, 1998; Malisch C.S. *et al*, 2017).

The feed obtained from the culture of sainfoin has a high nutritional value expressed through a balanced energy-protein ratio, this fact determines its complete consumability even in more advanced vegetation phases. Thus, sainfoin is used in the feeding of animals in the form of hay, green mass or pickled fodder, due to the high nutritional value of the feed (Carbonero C.H. *et al*, 2011; Özbek H., 2011; Jafari A.A. *et al*, 2014).

The main objectives for seed production and multiplication are represented by maintaining the genetic structure, production capacity and resistance qualities, maintaining a good phytosanitary state of the seed of the variety/hybrids and the provision of the necessary quantities of seeds of high biological value.

The production of seed material is affected by variable climatic conditions, in particular by diminishing the quantities that can be obtained, but also by affecting the quality of the material (Delgado I. *et al*, 2008; Dragomir N., 2009).

The quality parameters of the seed material produced in the authorized units are analyzed by ITCSMS (Territorial Inspectorate for Seed and Propagating Material Quality) Vaslui which, based on Romanian Order no. 155/2010, is based on, issue an Official Quality Document (DOC) or an Official Analysis Bulletin (BAO).

The study followed the influence of climatic conditions specific to the area of Research and Development Station for Meadows Vaslui, Solesti location, on seed production and quality of the seed material on *Onobrychis vicifolia* Scop., Anamaria Variety.

MATERIAL AND METHOD

The research was conducted during the period of March to October 2023, at the Research and Development Station for Meadows (RDSM) Vaslui (46°40'-36°10' north latitude and 27°44'-20°40' east longitude).

The researches analyzed the influence of average monthly and daily temperatures and the distribution of average monthly and daily rainfall on sainfoin (*Onobrychis viciifolia* Scop.), Anamaria variety, in the second year of vegetation, respectively:

▪ TP - total seed production (kg);

▪ SP - average seed production (kg·ha^{-1});

▪ %PPS - percentage of the productive potential of the species/variety;

▪ P - purity of seeds (%);

▪ Germination parameters:

▫ G - total germination (%);

▫ GE - germination energy (%);

▫ HS - hard seeds (%);

▫ AG - abnormal germs (%);

▫ DS - dead seeds (%);

▪ MMB - mass of 1000 grains or seed index (g).

The quality parameters were analyzed within ITCSMS Vaslui.

Results were statistically interpreted by analyzing variance and calculating their limit differences (DL).

For the characterization of climatic conditions, data taken from the meteorological station (uMETOS CLIMA, firmware: 3.02) of RDSM Vaslui were used.

Were analyzed in detail the climatic conditions from 01.02.-31.07.2023 period.

RESULTS AND DISCUSSION

In the RDSM Vaslui, during 2019-2023 agricultural period the climatic conditions were characterized by higher than normal annual average temperatures, both during the year, as well as during the vegetation period and the precipitation deficit recorded in some agricultural years (considered to be very dry), but also by the uneven rainfall distribution (figure 1). These conditions limit the number of species that can be improved and grown in the geographical area of the Vaslui SCDP, and the extreme climatic conditions in recent years make the created genetic material no longer adapted to new conditions, being imposed, by this aspect, the creation of new varieties, on a continuous basis.

The production of seed material is also affected by these new conditions, in particular by reducing the quantities that can be obtained, but also by affecting the quality of the seed material (getting seeds with germination below the normal one, in saoinfoin).

Table 1 shows the quantities of seed material produced in the RDSM Vaslui during the study period, respectively 2020-2023. The average productions made at *Onobrychis vicifolia* Scop., Anamaria variety was between 203 kg·ha^{-1} in 2022, being achieved only 14.5 % of the productive potential of the species - %PPS, and 844 kg·ha^{-1} in 2023, 60.3 % of the productive potential of the species - %PPS being achieved.

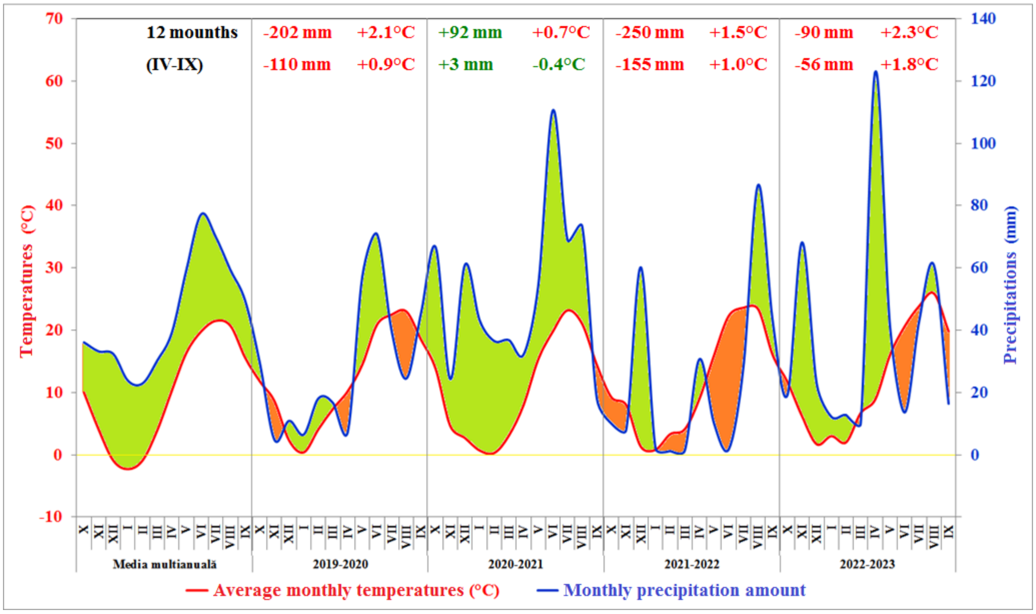


Figure 1. Climadiagram of agricultural period 2019-2023 (RDSM Vaslui)

Table 1

Production obtained in the sainfoin Anamaria variety grown within the RDSM Vaslui

Year	TP (kg)	S (ha)	SP (kg·ha^{-1})	PPS (kg·ha^{-1})	%PPS
2020	11472	14.85	773	1400	55.2
2021	7070	11.20	631		45.1
2022	3110	15.30	203		14.5
2023	**28300**	**33.55**	**844**		**60.3**

Following the analysis of the purity and germination of the seed material produced based on Order no. 155/2010 issues a certificate, it can come to the following two situations:

▪ the seeds correspond to the required standard, in which case the batch of seed analysed is certified;

▪ the seed shall have at least one of the two indicators analysed below the minimum value, in which case the batch of seed analysed is not certified but may be marketed as non-certified seed.

From the analysis of the results obtained in the period 2020-2023 (table 2), it emerged that the seed material produced could not be fully certified because in year 2023, at Anamaria sainfoin variety, germination were only 55 %, 20 % below the standardised limit, 75% for germination, respectively. Purity was 99% each year. Thus, from this point of view, the seeds met the minimum requirement of 95 %.

Table 2

Elements of technical quality obtained obtained at sainfoin Anamaria variety grown within the RDSM Vaslui

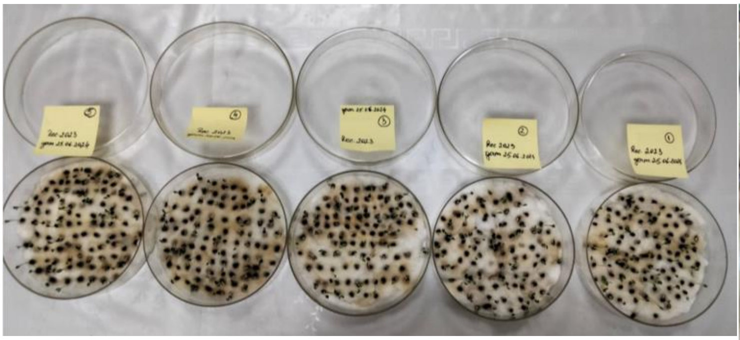
Year		Quality indicators						
		P (%)	G (%)	GE (%)	HS (%)	AG (%)	DS (%)	MMB (g)
2020		99	83^{***}	68^{**}	0^{o}	6	11^{oo}	20.21
2021		99	83^{***}	65^{o}	0^{o}	7	10^{oo}	18.36
2022		99	75	66	5^{***}	9^{*}	11^{oo}	19.24
2023		99	**55^{ooo}**	64^{oo}	0^{o}	5^{o}	**40^{***}**	17.39
Average		99^{Mt}	74^{Mt}	66^{Mt}	1^{Mt}	7^{Mt}	18^{Mt}	
LSD	*0.5 %*	*0,2*	*5*	*1*	*1*	*2*	*5*	
	0.1 %	*0,3*	*7*	*2*	*2*	*3*	*7*	
	0.01 %	*0,4*	*9*	*3*	*3*	*4*	*10*	

From the detailed analysis of laboratory samples, it turned out that 45% of the studied seeds did not form viable germs. Of these, almost 0% were hard seeds, around 5% formed abnormal germs and 40% were dead seeds (figure 2; figure 3).

Against the background of a previous very dry agricultural year and following optimal conditions in the spring of the agricultural year

2022-2023 (figure 4), sainfoin plants generated a huge number of inflorescences. But due to the lack of rainfall during this year's fruiting period (June), some of the seeds did not reach full maturity, the germs being destroyed by too high temperatures. Also, some of the seeds have been destroyed by too high temperatures and because they are brown, and the plants that have prepared for abundant fruiting, they could not counteract the effects of too high temperatures due to the lack of water in the soil.

But the biggest problem was that of too high maximum temperatures, which reached 35 ºC in the shade.



Day 1: 25.06.2024

Day 6: 30.06.2024

Figure 2. Seed material from the Anamaria sainfoin variety, harvest 2023 (original photo)

a - hard seeds

b - dead seeds

c - dead seeds

Figure 3. Seeds from the Anamaria s ainfoin variety, harvest 2023 (original photo) Day 7: 1.07.2024

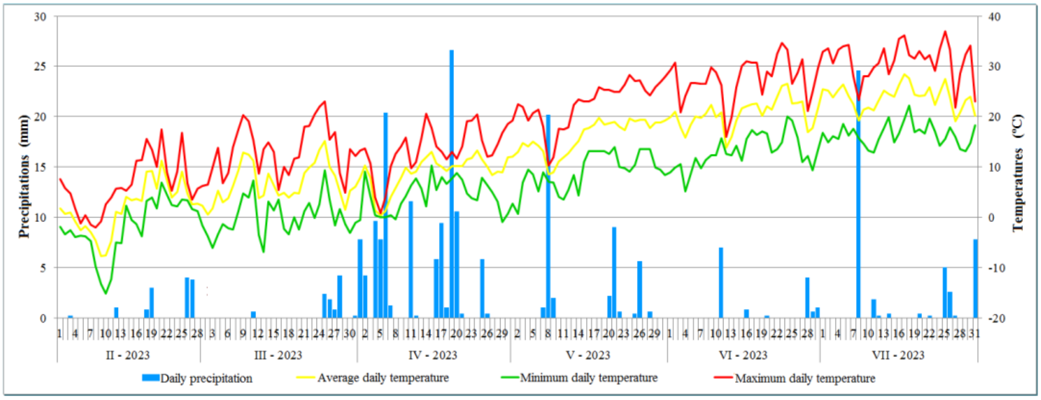


Figure 4. Climate conditions from 01.02.2023 - 31.07.2023 period (RDSM Vaslui)

Studies on the effect of heat stress on legume seeds (Gaur P.M. et al, 2015; Liu Y. et al, 2019; Sarkar S. et al, 2021; Aniruddha M. et al, 2023) classify these species as:

- species with high sensitivity > 27 ºC;
- species with average sensitivity > 32-33 ºC;
- species with low sensitivity > 38-43 ºC.

Onobrychis vicifolia Scop. species fits between those with low and medium sensitivity, being affected at temperatures of 35 ºC or higher.

The most important effects of high temperatures on legume seeds are represented by smaller cotyledons, embryos of smaller size, abortion of embryos and higher number of abnormal germs.

CONCLUSIONS

The peculiarities of the climatic conditions of the 2022-2023 agricultural year affected the quality of the seeds obtained from *Onobrychis vicifolia* Scop. Anamaria variety.

The seeds from the Anamaria sainfoin variety, produced in 2023 at the RDSM Vaslui had germination of only 55 %, 20 % less than the minimum value required by the Romanian legislation, so that the seeds can be certified.

Four years of results do not help to draw solid conclusions or to develop regressions with which to intuit issues related to seed production and seed quality in the future.

It may be recommended to continue research and bring into discussion and monitoring of soil water, but also of technological factors.

REFERENCES

1. Aniruddha M. Debashis P., Amrit L., Abhradip S., Nidhi B., Nandita M., Suman D., Pragati P.M., Shyamal K.C., 2023 - *Climate change impacts on seed production and quality: current knowledge, implications, and mitigation strategies*, Seed Science and Technology, 51(1)65-96, https://doi.org/10.15258/sst.2023.51.1.07.
2. Carbonero C.H., Mueller-Harvey I., Brown T.A., Smith L., 2011 - *Sainfoin (Onobrychis viciifolia): A beneficial forage legume*. Plant Genet. Resour.; Characterization Util. 9:70-85.
3. Delgado I., Andrés C., Munoz F., 2008 - Effect of the environmental conditions on different morphological and agronomical characteristics of sainfoin. Cahiers Options Méditerranéennes 79:199-202.
4. Dragomir, N., 2009 - *Pajiști și plante furajere* (Tehnologii de cultivare), Editura Europig, Timișoara.
5. Frame J., Charlton J.F.L., Laidlaw A.S., 1998 - *Alsike clover and sainfoin*, in: Frame J., Charlton J.F.L., Laidlaw A.S. (Eds.), Temperate forage legumes, CAB International, Wallingford, pp. 273-289.
6. Gaur P.M., Samineni S., Krishnamurthy L., Kumar S., Ghanem M.E., Beebe S., Rao I., Chaturvedi S.K., Basu P.S., Nayyar H., Jayalakshmi V., Babbar A., Varshney R.K., 2015 - *High temperature tolerance in grain legumes*, Legume Perspectives, 7:23-24, ISSN 2340-1559
7. Jafari A.A., Rasouli M., Tabaei-Aghdaei S.R., Shanjani P.S., Alizadeh, M.A., 2014 - *Evaluation of herbage yield, agronomic traits and powdery mildew disease in 35 populations of sainfoin* (*Onobrychis sativa*) *across 5 environments of Iran*. Romanian Agricultural Research, 31:41-48.
8. Liu Y., Li J., Zhu Y., Jones A., Rose R.J., Song Y., 2019 - *Heat Stress in Legume Seed Setting: Effects, Causes, and Future Prospects*, Front. Plant Sci., 10:1-12, https://doi.org/10.3389/fpls.2019.00938
9. Malisch C.S., Suter D., Studer B., Luscher A., 2017 - *Multifunctional benefits of sainfoin mixtures: Effects of partner species, sowing density and cutting regime*. Grass and Forage Science 72: 794-805.
10. Özbek H., 2011 - *Sainfoin, Onobrychis viciifolia* Scop.: *an important bee plant*. Uludag Bee J 11:51-62
11. Sarkar S., Khatun M., Mustafa Era F., Mominul Islam A.K.M. , Parvez Anwar M., Danish S., Datta R., Aminul Islam A.K.M., 2021 - *Abiotic Stresses: Alteration of Composition and Grain Quality in Food Legumes*, Agronomy, 11:1-24, https://doi.org/10.3390/agronomy11112238.

THE YIELD AND QUALITY OF FODDERS FROM SOME CORN HYBRIDS GROWN UNDER THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

Victor ŢÎŢEI

[1] "Alexandru Ciubotaru" National Botanical Garden (Institute) of Moldova State University, Republic of Moldova, MD 2002 Chisinau, 18 Pădurii str.

Corresponding author's email: vic.titei@ gmail.com

Abstract. *The results of the evaluation of the yield, biochemical composition and nutritive value of fodders, fresh mass and silage, from corn hybrids: 'PORUMBENI 374', 'PIONNER P 9757' and 'GOLDEN WEST GW 9003' grow in the Central part of the Republic of Moldova, are presented in this article. It was established the productivity of studied corn hybrids varied from 16.44 to 22.37 t/ha dry matter, the quality indices of the dry matter from whole-plant was 7.35-6.93% CP, 2.61-2.98 % EE, 32.11-40.00% CF, 17.24-18.40% NFE, 6.81-9.22% soluble sugars, 21.46-23.28% starch, 3.48-3.71% ash, 2.1-2.4 g/kg Ca, 2.1-2.4 g/kg P, 14.30-17.65 mg/kg carotene, 0.98-1.04 nutritive units/kg, 18.37-18.46 MJ/kg GE, 11.13-11.29MJ/kg ME, 6.69-6.97 MJ/kg NEl. The quality indices of the prepared silage from studied corn hybrids was: pH= 3.73-3.92, 7.4-8.09 g/kg acetic acid, 0-0.2g/kg butyric acid, 27.8-37.4 g/kg lactic acid, 308.4-345.3 g/kg dry matter with 6.83-7.29% CP, 3.62-3.94% EE, 16.47-19.02% CF, 66.22-60.69% NFE, 0.79-1.81 % sugar, 23.72-24.54 % starch, 3.47-3.55% ash, 2.3-2.7 g/kg Ca, 2.4-2.7 g/kg P, 20.02-28.02 mg/kg carotene, 0.96-1.00 nutritive units/kg, 18.53-18.69 MJ/kg GE, 11.27-11.60 MJ/kg ME, 6.89-7.17 MJ/kg NEl.*

Keywords: *biochemical composition, corn hybrids, fresh mass, hybrid 'GOLDEN WEST GW 9003', hybrid 'PIONNER P 9757', hybrid 'PORUMBENI 374', silage.*

INTRODUCTION

Livestock constituted one of the main economic activities and plays an important role in the sustainable agricultural development and national economy, security and food safety of the Republic of Moldova. The revitalization and economic feasibility of animal husbandry dependent on the valorification of animals genetic potential, good health care, balanced feeding, diversification of animal products and its efficient marketing. Supplying high-quality roughage to livestock year-round results in high milk and meat production (MAŞNER et al. 2021). Corn or mais *Zéa máys* L., is an annual, monocotyledonous, dioecious herb of the Poaceae family with C_4 photosynthesis type, native from Central America— is, after wheat and rice, the most important crop in various parts of the world and has adapted to different climatic and soil conditions. It is crop of versatile use: animal forage, food source for human nutrition after undergoing various industrial processing and also used for renewable energy production (CĂBULEA, 2004; VÎNTU et al. 2010; HERRMANN et al. 2016; SCARLAT et al. 2017; COŞMAN et al., 2018, 2023; MUNTEAN et al. 2018; KINTL et al. 2023). Whole-crop corn is a major crop in many dairy production systems used as fresh forage and for silage production, resulting in a valuable feedstuff for dairy cattle that is stable for a long period of time (COŞMAN, 2014; ESEN et al., 2022; SHARIF et al., 2023). It is a known fact that the productivity and nutritional value of forages is dependent largely on seasonal temperature, light and rainfall trends, soil type, energy inputs applied over the growing cycle and, to a very large extent, on the genetics of the variety/hybrid within the species.The objective of this study was to evaluate the chemical composition and nutritive value of forages from corn hybrids 'PORUMBENI 374', 'PIONNER P 9757' and 'GOLDEN WEST GW 9003' grown under the conditions of the Republic of Moldova

MATERIALS AND METHODS

The local corn hybrid '*PORUMBENI* 374' created at the Institute of Crop Science "*PORUMBENI*" and imported corn hybrids *'PIONNER P 9757'* and *'GOLDEN WEST GW 9003'*, cultivated in the experimental plot of the Technological Experimental Station "Paşcani", Criuleni district, Republic of Moldova, served as subjects of the research.

The studied corn hybrids were sown in early May at the same density of 60 thousand seeds per ha with a row spacing of 70 cm. All technological procedures in the process of growing these hybrids were identical. The corn whole plant was harvested manually in kernel wax stage. The harvested plants were chopped into 1.5-2.0 cm small pieces, with a laboratory forage chopper, the dry matter content was detected by drying samples up to constant weight at 105°C. The silage was prepared from chopped green mass, compressed in well-sealed glass containers, stored at ambient temperature (18-20°C). After 45 days, the containers were opened, and the sensorial and fermentation indices of the conserved forage were determined in accordance with standard laboratory procedures – the Moldavian standard SM 108*. The fresh mass and fermented fodder samples were dehydrated in an oven with forced ventilation at a temperature of 60°C; at the end of the fixation, the biological material was finely ground in a laboratory ball mill. The evaluation of fodder quality: crude protein (CP), crude fat (EE), crude cellulose (CF), nitrogen-free extract (NFE), soluble sugars (SS), starch, ash, calcium (Ca), phosphorus (P), carotene, silage pH index, concentration of organic acids (lactic, acetic and butyric) in free and fixed state were carried out in the Laboratory of Nutrition and Forage Technology of the Scientific-Practical Institute of Biotechnology in Animal Husbandry and Veterinary Medicine Maximovca, in accordance with the methodological indications. The gross energy (GE), metabolizable energy (ME), net energy for lactation (NEl) were calculated according to standard procedures. The gross energy (GE), metabolizable energy (ME), net energy for lactation (NEl) were calculated according to standard procedures:

GE= 23.9xCP+39.8xEE+20.1xCF+17.5x NFE

ME= (14.07+0.0206xEE-0.0147xCF-0.0114x CP) x4.5%

NEl= 9.10+0.0098xEE-0.0109xCF-0.073xCP

RESULTS AND DISCUSSION

The bio-morphological characteristics of the corn whole plant have a significant impact on the yield, nutrient content and forage value. It was found that yield of corn hybrid '*PORUMBENI* 374' was 56.94 t/ha fresh mass or 18.23 t/ha dry matter, corn hybrid *'PIONNER P 9757'*- 64.80t/ha fresh mass or 22.37 t/ha dry matter and corn hybrid *'GOLDEN WEST GW 9003'*- 51.84 t/ha fresh mass or 16.44 t/ha dry matter. Some authors have mentioned various findings about the biological peculiarities and forage productivity of corn hybrids. SCARLAT et al. (2017) stated that depending of period and sowing density, rows distance and the use of corn hybrids forage yield varied from 12.33 to 29.61 t/ha dry matter. OSORIO-SANTIAGO et al. (2022) mentioned that in climatic conditions of Valle del Mezquital, Hidalgo, Mexico the best green matter production of the corn hybrid DK-4018 was 114.6 t/ha. KINTL et al. (2023) reported that in Czech Republic the fresh matter yield of *Zea mays* crop was 61.34 t/ha with 26.9% dry matter content. TORIKOV et al. (2024) found that in the conditions of the south-west of the Central region of Russia on the gray forest medium loamy soil the corn hybrids 'Baikal', 'MA 198', 'Mashuk 185 MV', 'Mashuk 250 SV' had the highest yield of green mass — from 54.42 to 64.76 t/ha, while a low leafiness of the stems, the hybrids 'Voronezh 160 SV', 'Mashuk 175 MV', 'Mashuk 168', 'MA 1919', 'Pyatigorsky 146 MV', 'MA 171' formed green mass from 25.18 to 37.19 t/ha. Analysing the results of the biochemical composition of dry matter from whole-plant of studied corn hybrids, Table 1, we would like to mention that the concentration of nutrients was 7.35-6.93% CP, 2.61-2.98 % EE, 32.11-40.00% CF, 17.24-18.40% NFE, 6.81-9.22% soluble sugars, 21.46-23.28% starch, 3.48-3.71% ash, 2.1-2.4 g/kg Ca, 2.1-2.4 g/kg P, 14.30-17.65 mg/kg carotene. The nutritive value of corn hybrids dry matter was 0.98-1.04 nutritive units/kg, 18.37-18.46 MJ/kg GE, 11.13-11.29MJ/kg ME, 6.69-6.97 MJ/kg NEl. The fresh fodder from corn hybrid *'PIONNER P 9757'* was characterised by higher content of crude protein, crude fats, nitrogen free extract and soluble sugars, low calcium and phosphorus content. The fresh fodder from corn hybrid 'GOLDEN WEST GW 9003' had high concentration of carotene, nitrogen free extract, starch, phosphorus and low amounts of crude cellulose. The gross and metabolizable energy concentrations in fresh fodder from corn hybrids do not differ significantly. The green fodder from corn hybrids '*PIONNER P 9757'* and *'GOLDEN WEST GW 9003'* was characterised by higher concentrations of net energy for lactation.

Different results regarding the biochemical composition and the nutritive value of the corn fresh mass are given in the specialized literature. DALE et al. (2011) revealed that the harvested corn whole plants had a different nutrient content, thus corn stalk+leaves dry matter contained 3.79-7.97 % CP, 38.94-46.46 % CF, 45.51-56.22% ADF, 72.48-79.66% NDF, 6.14 - 9.89% ADL, but corn ear 2.51-5.83 % CP, 6.93-12.94 % CF, 2.48-16.81% ADF, 18.11-35.43% NDF, 0.51-4.13% ADL. CARPICI et al. (2017) reported that forage quality of second crop maize depending on the plant density and nitrogen fertilization rate hybrids, plants density was: 4.7-7.9% CP, 20.2-27.7% ADF, 39.6-50.6%. SCARLAT et al. (2019) revealed that depending on the hybrids, plants density and the rows distance the corn forage quality were: 8.37-10.25% CP, 24.93-27.93% ADF, 35.32-40.23% NDF, RFV=155.7-182.7. Ensiling is a very important method of conserving forage; it retains most of the nutrients and other valuable qualities of green fodder (succulence, dietetic qualities and high digestibility), it is an important agricultural technique for maintaining and increasing the productivity of herds, especially during the off-season, when there is scarcity of food for husbandry herbivorous animals, its preparation being an excellent strategy in reducing feed costs and increasing profitability. The fermentation quality, nutrient content and energy value of prepared corn silages are shown in Table 2. It has been determined that dry matter content varied from 308.4 g/kg hybrid *'GOLDEN WEST GW 9003'* to 345.3 g/kg hybrid *'PIONNER P 9757'*. The pH index of studied corn silages was 3.73-3.92, the concentrations of organic acids varied from 36.7g/kg in '*PORUMBENI* 374' silage to 45.0g/kg *'GOLDEN WEST GW 9003'* silage and most amounts of organic acids were in fixed form. The lactic acid constituted 75.75-83.12% of total organic acids. The higher content of acetic acid was detected in '*PORUMBENI* 374' silage. The concentration of nutrients and energy in prepared silages was 6.83-7.29% CP, 3.62-3.94% EE, 16.47-19.02% CF, 66.22-60.69% NFE, 0.79-1.81 % sugar, 23.72-24.54 % starch, 3.47-3.55% ash, 2.3-2.7 g/kg Ca, 2.4-2.7 g/kg P, 20.02-28.02 mg/kg carotene, 0.96-1.00 nutritive units/kg, 18.53-18.69 MJ/kg GE, 11.27-11.60 MJ/kg ME, 6.89-7.17 MJ/kg NEl. It was found that during the process of ensiling, the amounts of crude fats and carotene grew considerably in both corn silages. In the prepared wheat silage, the concentrations of crude protein, nitrogen free extract, ash increased. The higher concentration of crude protein and crude fats was detected in the silage from hybrid '*PORUMBENI* 374', the high level of nitrogen free extract, starch and low concentration of crude cellulose was detected in the silage from hybrid *'GOLDEN WEST GW 9003'*, which had a positive impact on net energy for lactation. Some authors mentioned various findings about the corn silage quality. COŞMAN (2014) studied the silage quality from diverse crops, found that corn silage contained 310.7 g/kg DM, pH=3.51, 37.0 g/kg lactic acid, 5.3 g/kg acetic acid, 4.44% CP, 2.84% EE, 21.61% CF, 4.91% ash and 15.2 mg/kg carotene; sugar sorghum silage – 213.4 g/kg DM, pH=3.49, 32.1 g/kg lactic acid, 23.0 g/kg acetic acid, 3.25% CP, 2.41% EE, 32.97% CF, 6.43% ash and 4.3 mg/kg carotene; but in amaranth silage – 232.9 g/kg DM, pH=4.02, 25.7 g/kg lactic acid, 10.1 g/kg acetic acid, 9.69% CP, 3.58% EE, 26.19% CF, 10.1% ash and 11.4 mg/kg carotene. HERRMANN et al. (2016) remarked than maize silage had 302 g/kg dry matter and 95.8 % organic matter, pH= 3.7, 5.1 % lactic acid, 1.6 % acetic acid, 7.8 % CP, 2.6 % EE, 41.2 % NDF, 24.0 % ADF, 2.9 % ADL.

Table 1.

The biochemical composition and nutritional value of fresh mass from studied corn hybrids

Indices	*PORUMBENI* 374	PIONNER P 9757	*GOLDEN WEST* GW 9003
Dry matter content (DM), g/kg FM	320.2	345.2	317.2
Crude protein (CP), % DM	7.26	7.35	6.93
Crude fats (EE), % DM	2.83	2.98	2.61
Crude cellulose (CF), % DM	18.40	17.58	17.24
Nitrogen free extract (NFE), % DM	67.92	68.38	69.73
Soluble sugars (SS), % DM	7.55	9.22	6.81
Starch, % DM	22.79	21.46	23.28
Ash, % DM	3.59	3.71	3.48
Nutritive units, kg FM	0.32	0.34	0.33
Nutritive units, kg DM	1.00	0.98	1.04
Gross energy (GE), MJ/kg	18.46	18.44	18.37
Metabolizable energy (ME), MJ/kg	11.13	11.26	11.29
Net energy for lactation (NEl), MJ/kg	6.69	6.93	6.97

Calcium (Ca), g/kg DM	0.24	0.21	0.23
Phosphorus (P), g/kg DM	0.22	0.21	0.24
Carotene, mg/kg	14.30	15.15	17.65

Table 2.

The fermentation quality, nutrient content and energy value of silage from studied corn hybrids

Indices	*PORUMBENI* 374	PIONNER P 9757	*GOLDEN WEST* GW 9003
Dry matter content (DM), g/kg	319.5	345.3	308.4
pH index	3.92	3.79	3.73
Content of organic acids, g/kg DM	36.7	44.8	45.0
Free acetic acid, g/kg DM	4.3	3.7	3.6
Free butyric acid, g/kg DM	0	0	0
Free lactic acid, g/kg DM	12.9	19.1	16.7
Fixed acetic acid, g/kg DM	4.6	4.2	3.8
Fixed butyric acid, g/kg DM	0	0	0,02
Fixed lactic acid, g/kg DM	14.9	17.8	20.7
Total acetic acid, g/kg DM	8.9	7.9	7.4
Total butyric acid, g/kg DM	0	0	0.2
Total lactic acid, g/kg DM	27.8	36.9	37.4
Acetic acid, % of organic acids	24.25	17.63	16.44
Butyric acid, % of organic acids	0	0	0.44
Lactic acid, % of organic acids	75.75	82.37	83.12
Crude protein (CP), % DM	7.28	7.11	6.83
Crude fats (EE), % DM	3.94	3.85	3.50
Crude cellulose (CF), % DM	19.02	18.00	16.47
Nitrogen free extract (NFE), % DM	66.22	67.57	69.69
Soluble sugars (SS), % DM	0.91	1.81	0.79
Starch, % DM	24.54	23.73	24.82
Ash, % DM	3.55	3.47	3.52
Nutritive units, kg silage	0.32	0.33	0.31
Nutritive units, kg DM	1.00	0.96	1.00
Gross energy (GE), MJ/kg DM	18.69	18.75	18.53
Metabolizable energy (ME), MJ/kg DM	11.27	11.40	11.60
Net energy for lactation (NEl), MJ/kg DM	6.89	6.99	7.14
Calcium (Ca), % DM	0.27	0.23	0.23
Phosphorus (P), % DM	0.27	0.24	0.25
Carotene, mg/kg	28.02	20.02	26.70

ŢÎŢEI & ACBAŞ (2018) reported that the dry matter content and forage value of *Zea mays* silage were 294.6 g/kg DM, pH=4.25, 27.6 g/kg lactic acid, 6.2 g/kg acetic acid, 6.52% CP, 3.23% EE, 20.33% CF, 65.66% NFE, 4.26% ash, 25.34 % ADF, 48.47 % NDF, 3.35% ADL, 23.13% HC, 21.99% Cel, 70.1% DDM, 64.4% DOM, RFV=132.

ESEN et al. (2022), mentioned that the dry matter content and the chemical composition of corn ensiled material was: 247.1 g/kg DM with 7.54% CP, 6.73% ash, 55.44 % NDF, 30.90% ADF, 4.73% ADL, 24.54% HC, 26.17% Cel, pH =3.90, 3.95 g/kg free lactic acid, RFV=108.9. KINTL et al. (2023) remarked that dry matter content and forage value of *Zea mays* silage were 212.3 g/kg DM, 15.6% CP, 2.24% EE, 23.48% CF, 12.37% carbohydrates, 19.83 % starch, 4.90% ash, 27.68 % ADF, 58.11 % NDF, 3.43% lighin. According to COŞMAN et al. (2023) the silage quality prepared from corn plant harvested in kernel milk stage was 202.5-262.8 g/kg DM, 7.63-9.13% CP, 2.35-3.27% EE, 26.65-28.05% CF, 45.85-50.72% NFE, 1.35-1.79 % sugar, 15.15-28.00 % starch, 5.50-7.43% ash, 2.2-3.1 g/kg Ca, 1.7-2.2 g/kg P, 15.15-28.00 mg/kg carotene; corn silage prepared in kernel milk-wax stage- 277.0-317.2 g/kg DM, 5.56-8.00% CP, 2.19-4.02% EE, 18.42-26.48% CF, 54.47-61.35% NFE, 1.65-6.56 % sugar, 10.18-17.33 % starch, 3.92-5.63% ash, 1.6-3.8 g/kg Ca, 1.2-2.2 g/kg P, 10.80-16.17 mg/kg carotene; while silage prepared in kernel wax stage- 30.73-40.96 g/kg DM, 6.63-7.31% CP, 2.82-3.82% EE, 14.50-18.41% CF, 61.63-66.90% NFE, 1.59-2.47 % sugar, 19.32-27.45 % starch, 3.41-3.93% ash, 1.6-3.3 g/kg Ca, 1.5-2.9 g/kg P, 19.67-21.02mg/kg carotene SHARIF et al. (2023) reported that the the quality of corn silage was pH=3.90, 327.8 g/kg DM 1.95 % lactic acid, 1.28 % acetic acid, 8.35 % CP, 2.34 % EE, 22.12% CF, 5.12% ash, 51.12 % NDF, 26.12 % ADF.

CONCLUSIONS

1. The productivity of studied corn hybrids varied from 16.44 to 22.37 t/ha dry matter.

2. The nutrient concentration and feed value of the dry matter from whole-plant was 7.35-6.93% CP, 2.61-2.98 % EE, 32.11-40.00% CF, 17.24-18.40% NFE, 6.81-9.22% soluble sugars, 21.46-23.28% starch, 3.48-3.71% ash, 2.1-2.4 g/kg Ca, 2.1-2.4 g/kg P, 14.30-17.65 mg/kg carotene, 0.98-1.04 nutritive units/kg, 18.37-18.46 MJ/kg GE, 11.13-11.29MJ/kg ME, 6.69-6.97 MJ/kg NEl.

3. The prepared silage from studied corn hybrids is characterized by pH= 3.73-3.92, 7.4-8.09 g/kg acetic acid, 0-0.2g/kg butyric acid, 27.8-37.4 g/kg lactic acid, 308.4-345.3 g/kg dry matter with 6.83-7.29% CP, 3.62-3.94% EE, 16.47-19.02% CF, 66.22-60.69% NFE, 0.79-1.81 % sugar, 23.72-24.54 % starch, 3.47-3.55% ash, 2.3-2.7 g/kg Ca, 2.4-2.7 g/kg P, 20.02-28.02 mg/kg carotene, 0.96-1.00 nutritive units/kg, 18.53-18.69 MJ/kg GE, 11.27-11.60 MJ/kg ME, 6.89-7.17 MJ/kg NEl.

The researched corn hybrids *'PORUMBENI 374'*, *'PIONNER P*

9757' and *'GOLDEN WEST GW 9003'* can be cultivated for both grain and forage production in Republic of Moldova.

ACKNOWLEDGEMENTS

This study has been financially supported by the subprogram no. 01.01.02 *"Identification of valuable forms of plant resources with multiple uses for the circular economy".*

REFERENCES

1. Căbulea I. (2004). *Porumbul* – Studiu monografic, Ed. Academiei Române. 652p.
2. Carpici E.B., Aşik B.B., Celik N., Dogan R. (2017). Effects of plant density and nitrogen fertilization rate on forage yield and quality of second crop maize (*Zea mays* L.). *Romanian Agricultural Research*, 34:255-262.
3. Coşman S. (2014). Caracteristica comparativă a componenței chimice și valorii nutritive a silozurilor obținute din porumb, amarant și sorg zaharat. In: *Rolul agriculturii în acordarea serviciilor ecosistemice şi sociale.* Edit. Universitatea de Stat „Alecu Russo", Bălți, 225-229.
4. Coşman S., Bahcivanji M., Coșman V., Garaeva S., Mitina T. (2018). *Ghid practic de date actualizate.* Maximovca, 58 p.
5. Coşman S., Danilov A., Petcu I., Ţîţei V., Coşman V., Bahcivanji M. (2023). *Diversificarea bazei furajere prin studierea unor furaje noi şi mai puțin cunoscute in Republica Moldova.* Maximovca: Print-Caro, 340 p.
6. Dale L.M., Rotar I., Thewis A., Lecler B., Ceclan O., Beaten V. (2011). Maize for silage quality determinate by classical and NIRS method. *Romanian Journal of Grasslands and Forage Crops*, 4:8-22.
7. Esen S., Okuyucu B., Koc F., Özdüven L. (2022). Determination of nutritional quality and aerobic stability of sorghum, maize, and sorghum-maize mixture silages. *Tekirdağ Ziraat Fakültesi Dergisi,* 19(1): 61-69.
8. Herrmann C., Idler C., Heiermann M. (2016). Biogas crops grown in energy crop rotations: linking chemical composition and methane production characteristics. *Bioresource Technology*, 206: 23–35.
9. Kintl A., Hunady I., Vítez T., Brtnický M., Sobotková J., Hammerschmiedt T., Vítezová M., Holátko J., Smutný V., Elbl J. (2023). Effect of legumes intercropped with maize on biomass yield and subsequent biogas production. *Agronomy, 13, 2775. https://doi.org/10.3390/ agronomy13112775*

9. Maşner O., Coşman, S., Macari V., Danilov A., Petcu I. (2021). *Bunele practici de adaptare a sectorului zootehnic la schimbările climatice: Ghid practic pentru producătorii agricoli.* Chișinău, 200 p.
10. Muntean I., Ţîţei V., Gudima A., Armaş A., Gadibadi M. (2018). Biomass quality of some Poaceae species and possible use for renewable energy production in Moldova. *Scientific Papers. Series A. Agronomy*, 61(1):497-502.
11. Osorio-Santiago V.J., Aguado-Rodríguez G.J., Rodríguez Martínez N., Rodríguez-Ortega L.T., Alviter-Aguilar A., Rodríguez Ortega A. (2022). Corn (*Zea mays* L.) green matter production in different sowing densities. *Agro Productividad,* 15(4):113-119. https://doi.org/10.32854/agrop. v15i4.2170
12. Scarlat M., Samuil C., Stavarache M., Nazare A.-I., Vîntu V. (2017). Influence of some technological factors on productivity of maize silage in the conditions of depression Jijia-Bahlui. *Romanian Journal of Grassland and Forage Crops, 16:57-63.*
13. Scarlat M., Samuil C., Stavarache M., Nazare A.-I., Vîntu V. (2019). The influence of some technological factors on the quality of corn silage in the conditions of Jijia-Bahlui depression. *Romanian Journal of Grassland and Forage Crops*, 20:47-54.
14. Sharif S., Hanif N.Q., Ghazanfar S., Imran M., Naiel M. A., Alagawany M. (2023). Dominance of bacillus sp. alter microbiological and nutritional quality and improve aerobic stability of the corn silage. *Rendiconti Lincei. Scienze Fisiche e Naturali*, 34(1):283-293.
15. Ţîţei V., Acbaș I. (2018). Prospects of some new and non-traditional fodder crops for silage in Republic of Moldova. *Archiva Zootechnica*, 2018, 21(2): 69-80.
16. Torikov V., Melnikova O., Nalivaiko T. (2024). Comparative assessment of the yield of green mass and grain of corn hybrids in the conditions of the Central Regions of Russia. *Agrarian science*, 113-118. 10.32634/0869-8155-2024-384-7-113-118.
17. Vîntu V., Samuil, C., Stavarache, M., Muntianu, I., Popovici C.I. (2010). Research on the influence of some technological factors on production components of biomass in maize (Zea maïs L.) for bioenergy under the forest steppe conditions of Moldova. *Lucrări Ştiinţifice, seria Agronomie* 53(2):257-261.
* SM 108:1995 (1996): *Siloz din plante verzi.* Condiţii tehnice. Moldovastandart.

RESEARCH ON SEED QUALITY PRODUCED AT *Bromus inermis* Leyss. SPECIES

Elena-Manuela (BĂDRĂGAN) VACARCIUC*, DUMITRIU (ACATRINEI) Simona*, DUDĂU Ana-Maria *, STAVARACHE Elena*, STAVARACHE Mihai*, SAMUIL Costel**

**Research and Development Station for Meadows Vaslui, Romania*
***University of Life Sciences "Ion Ionescu de la Brad", Iaşi, România*
**Corresponding author e-mail: vacarciucelenamanuela@yahoo.ro*

Abstract

Seed production is undoubtedly of particular importance for the overseeding or reseeding of permanent grasslands and the establishment of temporary meadows, by providing the necessary seed material with higher quality indices. The research conducted during the period 2021-2024, at the Research and Development Station for Meadows (RDSM), Vaslui (46°40' - 36°10' north latitude and 27°44' - 20°40' east longitude) pursued the influence of fertilization and the distance between rows on seed germination (%) and value of the 1000 grains mass (g) for smooth brome (Bromus inermis Leyss.*). The organized experience was trifactorial, 2×3×5 type, it was placed according to the method of subdivided plots, with the plot harvestable area of 20 m2 (2 m × 10 m), in three replications, and the studied factors were: A - variety (a_1 - Mihaela, a_2 - Iulia Safir), B - the distance between rows with three graduations (b_1 - 25 cm, b_2 - 37.5 cm and b_3 - 50 cm) and C - fertilization with five graduations (c_1 - unfertilized, c_2 - $N_{50}P_{50}$, c_3 - $N_{50}P_{50}K_{50}$, c_4 - $N_{75}P_{75}K_{75}$ and c_5 - $N_{100}P_{100}K_{100}$). Following the study, it was found that by applying mineral fertilized with $N_{75}P_{75}K_{75}$ and by sowing at 25 cm distances between rows seed quality was higher.*

Keywords: variety, distance between rows, fertilization

INTRODUCTION

Bromus inermis Leyss. Species or smooth brome is found in temperate areas of Asia, Europe and North America, being a perennial gramine with a high drought tolerance, frost, is widely used for the cultivation of temporary meadows and improving of permanent ones (Samuil C. *et al*, 2010; Saeidnia F. *et al*, 2019).

Smooth brome is a perennial grasses with high drought resistance (Raawe H., 2004). Well developed root system with many ramifications lead to the adaptability of different soil types (Rogalski M., 2004).

The role of this grasses is significant in the agricultural system, because they protect the soil from water erosion and wind erosion, enrich it with organic matter and help infiltrate precipitation (Goloborodko S.P. *and* Dymov O.M., 2019).

The grasslands contribute to the management of feed resources, atmospheric carbon storage, biodiversity conservation, beautify the landscape and provide spaces for recreational activities (Marusca T. *et al*, 2010).

Seed quality is vital for

agriculture, with increased production and the establishment of new crops particularly dependent on the seed stock. Seed size, weight, protein content, are closely related to seed quality (Marco D.G.D., 1990; Smart A.J. *and* Moser L.E., 1999; Snider J.L. *et al*, 2016; Sousa K.R. et al., 2016).

Although seed quality is affected by many factors, fertilizer management is particularly important. The deficiency of any of the macronutrients will significantly impede the growth of plants, reducing the quantity and quality of the yields obtained (Austin R.B., 1966).

MATERIAL AND METHOD

The purpose and objectives of the research carried out at the Research and Development Station for Meadows Vaslui were represented by the analysis of the influence of the interaction between variety, row distance and fertilization on seed germination (G %) and the mass of 1000 grains - MMB (g) to smooth brome (*Bromus inermis* Leyss.), in seed culture.

The research was carried out during the period 2021-2024, within the Research and Development Station for Meadows (RDSM) Vaslui (46°40'-36°10' north latitude and 27°44'-20°40' east longitude).

To achieve the proposed purpose, a trifactorial experience was organized, 2×3×5 type, placed according to the method of subdivided plots, with the plot harvestable area of 20 m^2 (2m x 10m), in three replications.

The studied factors were*:*

A - *variety* with two graduations (a_1 - Mihaela, a_2 - Iulia Safir),

B - *the distance between rows* with three graduations (b_1 - 25 cm, b_2 - 37.5 cm and b_3 - 50 cm),

C - *fertilization* with five graduations (c_1 - unfertilized, c_2 - $N_{50}P_{50}$, c_3 - $N_{50}P_{50}K_{50}$, c_4 - $N_{75}P_{75}K_{75}$ and c_5 - $N_{100}P_{100}K_{100}$).

The biological material used is represented by the varieties Mihaela and Iulia Safir, both varieties were created at the Research and Development Station for Meadows, Vaslui (Silistru D., 2010; Silistru D., 2011).

The fertilizers were applied early in the spring, at the start of plant vegetation.

Seed germination - G (%) was determined at the Territorial Inspectorate for Seed Quality and Propagating Material Vaslui, according to SR 1634/1999.

The mass of 1000 grains - MMB (g) of the seeds was determined for each experimental plot by weighing 100 seeds in eight repetitions, then the mean value obtained was multiplied by 10 (SR 7713/1999).

The results were statistically interpreted by analyzing variance and calculating last significant differences (LSD).

The climatic conditions of the experimentation period, namely 2021-2024, showed that the first year of the vegetation was a year with above average rainfall, thus the climadiagram of this agricultural year, 2020-2021, it was similar to the multiannual average. In the agricultural period 2021-2023, the two and three year vegetation, were two dry years, there were recorded rainfall in half compared to the multiannual average, in the third year of vegetation in the period of April to September there was precipitation deficit every month. The fourth year of vegetation, namely the agricultural year 2023-2024, was a year with high rainfall, there were recorded rainfall above the multiannual average, however, there have been periods of water stress and uneven distribution (figure 1).

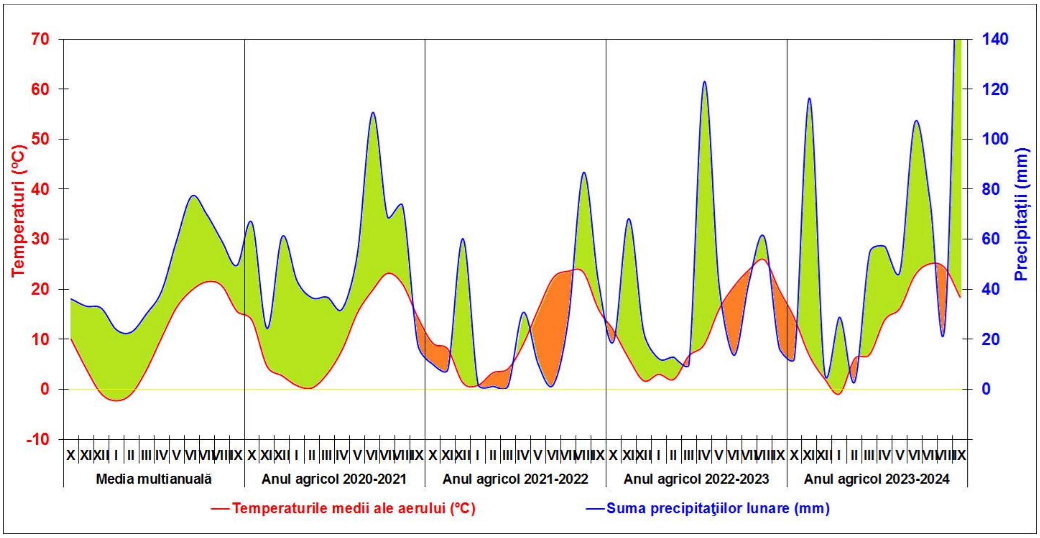


Figure 1. Climadiagram of agricultural period 2020-2024 (RDSM Vaslui)

RESULTS AND DISCUSSIONS

Seed germination is one of the most important quality parameters be of the seed material produced in the *Bromus inermis* Leyss. species and the mass of 1000 grains (MMB) is, also, one of the most important indicators of seed quality. Seeds with an above-average value of this indicator will store more energy, and from a practical point of view, in the technology of cultivation of smooth brome, the use of seeds with higher MMB value, under normal pedoclimatic conditions, it will cause a faster and more uniform emergence of the plants, and under the conditions of a water shortage in the soil, at the time of sowing, seeds can be sown deeper into the soil.

By improving the technology of cultivation of the *Bromus inermis* Leyss. species for the seed is also aimed at creating sowing material with larger values of germination and mass of 1000 grains (table 1).

In the three years of

production the average germination value was 94.3%, the lowest value was recorded in the second year of vegetation, of 89.3 % at the $a_2b_2c_1$ variant (Iulia Safir variety, sown at 37.5 cm between rows, unfertilized) and the highest value was recorded in the fourth year of vegetation of 97.3 %, at the $a_1b_3c_3$ variant (Mihaela variety, sown at 50 cm, fertilized with $N_{50}P_{50}K_{50}$) and $a_2b_2c_1$ variant (Iulia Safir variety, sown at 37.5 cm between rows, unfertilized).

Table 1

The influence of the interaction between the studied factors on seed germination in the *Bromus inermis* Leyss. species

Variant			Seed germination (G %)		
			Year II (2021-2022)	Year III (2022-2023)	Year IV (2023-2024)
a_1 - Mihaela variety (control)	b_1 - 25 cm (control)	c_1- unfertilized (c.)	94.3^{control}	95.7^{control}	93,0^{control}
		c_2 - $N_{50}P_{50}$	95.3	95.7	91,3
		c_3 - $N_{50}P_{50}K_{50}$	95.0	94.3	89,7^{oo}
		c_4 - $N_{75}P_{75}K_{75}$	95.0	95.0	91,3
		c_5 - $N_{100}P_{100}K_{100}$	92.3	93.3^{o}	94,3
	b_2 - 37.5 cm	c_1 - unfertilized	92.3	94.0	95,3*
		c_2 - $N_{50}P_{50}$	92.0	93.7	93,3
		c_3 - $N_{50}P_{50}K_{50}$	91.3^{o}	93.3^{o}	91,0
		c_4 - $N_{75}P_{75}K_{75}$	91.0^{oo}	92.3^{oo}	92,3
		c_5 - $N_{100}P_{100}K_{100}$	89.7^{ooo}	90.3^{ooo}	94,3
	b_3 - 50 cm	c_1 - unfertilized	91.0^{oo}	92.3^{oo}	96,0**
		c_2 - $N_{50}P_{50}$	92.0	93.7	96,0**
		c_3 - $N_{50}P_{50}K_{50}$	92.0	94.0	97,3***
		c_4 - $N_{75}P_{75}K_{75}$	93.0	94.7	95,3*
		c_5 - $N_{100}P_{100}K_{100}$	93.3	94.3	93,0
a_2 - Iulia Safir variety	b_1 - 25 cm	c_1 - unfertilized	94.7	95.3	97,0***
		c_2 - $N_{50}P_{50}$	95.0	95.7	96,0**
		c_3 - $N_{50}P_{50}K_{50}$	94.7	95.3	95,0
		c_4 - $N_{75}P_{75}K_{75}$	93.0	94.0	92,0
		c_5 - $N_{100}P_{100}K_{100}$	90.7^{oo}	92.0^{oo}	90,0^{oo}
	b_2 - 37.5 cm	c_1 - unfertilized	89.3^{ooo}	90.7^{ooo}	97,3***
		c_2 - $N_{50}P_{50}$	91.0^{oo}	92.0^{oo}	93,0
		c_3 - $N_{50}P_{50}K_{50}$	94.0	94.0	90,0^{oo}
		c_4 - $N_{75}P_{75}K_{75}$	94.7	94.7	91,3
		c_5 - $N_{100}P_{100}K_{100}$	94.3	94.3	93,0
	b_3 - 50 cm	c_1 - unfertilized	92.3	93.7	90,0^{oo}
		c_2 - $N_{50}P_{50}$	92.3	93.7	92,0
		c_3 - $N_{50}P_{50}K_{50}$	94.0	95.7	94,0
		c_4 - $N_{75}P_{75}K_{75}$	94.0	94.7	94,0
		c_5 - $N_{100}P_{100}K_{100}$	96.7	96.0	94,0
LSD		*0.5 %*	*2.5*	*2.2*	*2.1*
		0.1 %	*3.3*	*3.0*	*2.8*
		0.01 %	*4.3*	*3.9*	*3.7*

The years two and three of vegetation were years with less favorable climatic conditions. The separate influence of the factors studied manifested less. Year four of vegetation was a year favorable to the culture of smooth brome, with the increase in the distance between the rows increased and seed germination, instead with the increase of mineral fertilizer doses, seed germination was lower, significant and distinctly significant depending on the applied dose (table 2).

Table 2

The influence of the interaction between the studied factors on mass of 1000 grains in the *Bromus inermis* Leyss. species

Variant			MMB (grams)		
			Year II (2021-2022)	Year III (2022-2023)	YearIV (2023-2024)
a_1 - Mihaela variety (control)	b_1 - 25 cm (control)	c_1 - unfertilized (c.)	$3.72^{control}$	$3.27^{control}$	$3,64^{control}$
		c_2 - $N_{50}P_{50}$	3.81	3.55**	$3,38^{o}$
		c_3 - $N_{50}P_{50}K_{50}$	3.71	3.17	3,54
		c_4 - $N_{75}P_{75}K_{75}$	3.82	3.21	3,64
		c_5 - $N_{100}P_{100}K_{100}$	3.91	3.27	3,69
	b_2 - 37.5 cm	c_1 - unfertilized	3.79	3.24	$3,37^{o}$
		c_2 - $N_{50}P_{50}$	4.15**	3.29	$3,25^{oo}$
		c_3 - $N_{50}P_{50}K_{50}$	4.17***	3.32	$3,34^{o}$
		c_4 - $N_{75}P_{75}K_{75}$	4.43***	3.33	$3,29^{oo}$
		c_5 - $N_{100}P_{100}K_{100}$	4.34***	3.47*	$3,34^{o}$
	b_3 - 50 cm	c_1 - unfertilized	4.03*	3.21	3,60
		c_2 - $N_{50}P_{50}$	4.28***	3.30	3,53
		c_3 - $N_{50}P_{50}K_{50}$	4.27***	3.32	$3,37^{o}$
		c_4 - $N_{75}P_{75}K_{75}$	4.25***	3.50*	$3,00^{ooo}$
		c_5 - $N_{100}P_{100}K_{100}$	4.48***	3.26	$3,37^{o}$
a_2 - Iulia Safir variety	b_1 - 25 cm	c_1 - unfertilized	4.01*	3.20	$3,36^{o}$
		c_2 - $N_{50}P_{50}$	3.95	3.41	$3,27^{oo}$
		c_3 - $N_{50}P_{50}K_{50}$	4.02*	3.44	$3,24^{ooo}$
		c_4 - $N_{75}P_{75}K_{75}$	4.32***	3.22	$3,38^{o}$
		c_5 - $N_{100}P_{100}K_{100}$	4.40***	3.38	3,57
	b_2 - 37.5 cm	c_1 - unfertilized	3.94	3.26	$3,36^{o}$
		c_2 - $N_{50}P_{50}$	4.29***	3.30	$3,19^{ooo}$
		c_3 - $N_{50}P_{50}K_{50}$	4.27***	3.38	$3,34^{o}$
		c_4 - $N_{75}P_{75}K_{75}$	4.41***	3.45	$3,28^{oo}$
		c_5 - $N_{100}P_{100}K_{100}$	4.44***	3.21	$3,17^{ooo}$
	b_3 - 50 cm	c_1 - unfertilized	3.90	3.13	3,44
		c_2 - $N_{50}P_{50}$	4.22***	3.51*	3,55
		c_3 - $N_{50}P_{50}K_{50}$	4.27***	2.96^{oo}	$3,27^{oo}$
		c_4 - $N_{75}P_{75}K_{75}$	4.23***	3.14	3,52
		c_5 - $N_{100}P_{100}K_{100}$	4.18***	3.24	$3,15^{ooo}$
	LSD	*0.5 %*	*0.26*	*0.20*	*0.23*
		0.1 %	*0.29*	*0.27*	*0.31*
		0.01 %	*0.65*	*0.35*	*0.40*

In the three years of production the average mass value of 1000 grains was 3.54 g, the lowest value of the MMB being recorded in the third year of vegetation (table 2), of 2.96 g at the $a_2b_3c_3$ variant (Mihaela variety, sown at 50 cm between rows, fertilized with $N_{50}P_{50}K_{50}$). The highest value was recorded in the second year of vegetation of 4.48 g, was at the $a_1b_3c_5$ variant (Mihaela variety, sown at 37.5 cm between rows, fertilized with $N_{100}P_{100}K_{100}$).

In the case of the researches carried out, the factors of distance between rows and fertilization have positively influenced the value of the mass of 1000 grains, only in the second year of vegetation (table 2) while in the three and four years of vegetation their influence was insignificant.

CONCLUSIONS

From the point of view of the quality parameters analyzed, seed germination and mass of 1000 grains, interaction between the studied factors, respectively the cultivated variety, distance between rows and fertilization influenced the quality of the seeds differently, but these results were also influenced by the climatic conditions of this period.

In the three years of production, the Iulia Safir variety was superior to the Mihaela variety, obtaining seeds of superior quality, and by administering mineral fertilizers ($N_{75}P7_5K_{75}$ and $N_{100}P_{100}K_{100}$) and sowing at smaller distances between rows, seeds with higher quality indices were obtained.

For obtaining seed yields with a higher biological value in the species *Bromus inermis* Leyss. it is recommended to grow the variety Iulia Safir, sown at a distance of 25 - 37.5 cm between rows and fertilized with NPK in doses of 75-100 kg·ha^{-1}.

ACKNOWLEDGMENTS

The research topic is part of the project No. 26/20.01.2021, Project domain (according to the RDI 2014-2020 Strategy of MADR): Grasslands culture.

REFERENCES

1. +++++++ O.M., 2019 - *Global climate change: causes of occurrence and consequences for agricultural production in the Southern Steppe*. Melioratsiia i Vodne Hospodarstvo, 1:88-98.
2. Marco D.G.D., De M.D.G., 1990 - *Effect of seed weight, and seed phosphorus and nitrogen concentrations on the early growth of wheat seedlings*. Anim. Prod. Sci., 30:545-549.
3. Marușca T., Mocanu V., Cardașol V., Hermenean I., Blaj V.A., Oprea G., Tod M.A., 2010 - *Ghid de producere ecologică a furajelor de pajiști montane*. Edit. Universității Transilvania, Brașov.

4. Raawe H., 2004 - *About grass and legume species suitability for recultivation of semi-coke dumps*. Agronomy, 219:154-156.
5. Rogalski M., 2004 - *Meadow farming*. Academic handbook, Poland, ISBN 83-88841-96-3.
6. Saeidnia F., Majidi M.M., Mirlohi A., Bahrami S., 2019 - *Inheritance and combining ability of persistence and drought recovery in smooth bromegrass (Bromus inermis* Leyss.*)*, Euphytica 215:177, https://doi.org/10.1007/s10681-019-2500-8.
7. Samuil C., Vîntu V., Surmei G.M., Ionel A., 2010 - *Research on the behaviour of simple mixtures of perennial grasses and legumes, under the conditions of Moldavian forest-steppe*. Romanian Journal of Grassland and Forage Crops, Cluj-Napoca 2:69-81.
8. Silistru D., 2010 - *Soiul de obsigă nearistată Mihaela,* Oferta cercetării științifice pentru transfer tehnologic în agricultură, industria alimentară și silvicultură, Ed. Printech, vol. 13, pag. 13.
9. Silistru D., 2011 - *Soiul de obsigă nearistată Iulia Safir,* Oferta cercetării științifice pentru transfer tehnologic în agricultură, industria alimentară și silvicultură, vol. 14, pag. 22, Editura New Agris, București.
10. Smart A.J., Moser L.E., 1999 - *Switchgrass seedling development as affected by seed size*. Agron. J., 91:335-338.
11. Snider J.L., Collins G.D., Whitaker J., Chapman K.D., Horn P., 2016 - *The impact of seed size and chemical composition on seedling vigor, yield, and fiber quality of cotton in five production environments*. Field Crop Res., 193:186-195.
12. Sousa K.R., Aragão V.P.M., Reis R.S., Macedo A.F., Vieira H.D., C.L.M. de Souza, Floh E.I.S., Silveira V., Santa-Catarina C., 2016 - *Polyamine, amino acid, and carbohydrate profiles during seed storage of threatened woody species of the Brazilian Atlantic Forest may be associated with seed viability maintenance*. Braz. J. Bot., 39:985-995.

ASSESSMENT OF GRASSLAND PRODUCTIVITY IN MARINE SAND DUNE AREAS OF THE DANUBE DELTA

Daniyar MEMEDEMIN*,,***, MARUȘCA Teodor ***

*Research-Development Institute for Grasslands, 5 Cucului St., Brasov, 500128, Romania
** Ovidius University of Constanta, 1Universitatii Alley, 900470, Constanta, Romania
*** Corresponding author e mail: daniyar_memedemin@yahoo.com

Abstract

The permanent grasslands on the Chituc and Periteașca-Leahova marine sandbars have very low productivity, with an average vegetation coverage of 75-78% and a participation of forage species of 17-23%. On Chituc Sandbar productivity is higher due to the greater participation of the species Elymus elongatus and Chrysopogon gryllus, with a production of 3 t/ha of green fodder and a load of 0.35 LU/ha in 130 days of grazing season, a pastoral value of 13.1 and a milk production of 1,040 liters per hectare. With the vegetation being dominated by the species Bromus tectorum and Puccinellia spp, on the Periteașca-Leahova Sandbar the green fodder production is 0.68 t/ha. With an optimal load of 0.08 LU/ha and a pastoral value of 9.8, the milk production can be 780 l/ha in 130 days of grazing season. By evaluating the productivity of grasslands on marine sandbars or of other origins such as fluvial and continental ones, grazing capacity can be optimized, thus contributing to the conservation of biodiversity and the achievement of superior economic performance.

Keywords: marine sandbars, grassland vegetation, pastoral value, productivity

INTRODUCTION

The vegetation that can be assimilated to permanent grasslands in the evaluated area has been studied from a geobotanical perspective by several researchers (Popescu et al. 1997, et al. 2002, Petrescu 2007, Făgăraș et al. 2008a, Făgăraș et al. 2008b, Sanda et al. 2008, Doroftei et al. 2011, Doroftei & Covaliov 2013, Făgăraș 2015, Făgăraș et al. 2015).

In terms of productivity, there is less research on these grasslands, especially those on the sandbars, although they are used for grazing animals belonging to local communities. The grasslands on the sandbars fall into the group of non-zonal ones on saline soils and are thus affected by alkalization, a phenomenon that causes the degradation of the vegetal layer of these areas through the proliferation of harmful species (Oprea et al. 2022; Marușca 2023; Marușca et al. 2024). The evaluation of green fodder production per hectare and of the pastoral value are basic indicators for establishing the optimal animal load during the grazing season, an essential element for preserving biodiversity and avoiding the degradation of the more sensitive vegetal layer on the sand dunes (Marușca 2022). This paper presents the evaluation of the productivity of natural grasslands on the Chituc and Periteașca-Leahova sandbars in the Danube Delta.

MATERIAL AND METHOD

To evaluate the productivity of natural grasslands developed on coastal sands, two representative sandbars were studied both in terms of habitat conservation status and accessibility. The studied areas are partially in strictly protected areas, in the case of the Chituc Sandbar, and entirely in strictly protected areas, in the case of the Periteașca - Leahova Sandbar. (Figure 1).

Fig. 1 – Studied area

Access to strictly protected areas was based on research permits issued by the Danube Delta Biosphere Reserve Administration.

The two studied areas are located in the southern part of the Danube Delta Biosphere Reserve, the substratum of the evaluated surfaces being generally represented by unfixed sands of marine origin for the Chituc Sandbar and phreatic - humid sandy psamosoils (on marine deposits) frequently salinized for the Periteașca - Leahova Sandbar, the fertility of these soils being very low (Munteanu & Curelariu 1996).

For the vegetation study, 13 floristic surveys were carried out, according to the Klapp-Ellenberg percentage method (Mueller-

Dombois & Ellenberg 1974, Marușca 2019) of cormophyte participation in the vegetal layer, the data being collected between 2023-2024. The area evaluated in each sample station was 100 sq m.

The evaluation of grassland productivity was carried out according to the new method based on floristic survey proposed by Marușca (2019).

The potential milk production per hectare was determined after pastoral evaluation and application of a conversion coefficient established in dairy cow grazing experiences by Marușca et al (2018).

RESULTS AND DISCUSSIONS

In a first stage, 3 surveys were carried out on Chituc Sandbar, being determined 33 species of cormophytes (Table 1). The dominant species were *Elymus elongatus*, *Chrysopogon gryllus* and Artemisia tschernieviana each in one of the 3 relevee's. The most common species represented in the 3 surveys is *Euphorbia sequeriana* at 11.7%, which indicates the advanced stage of degradation of the vegetal layer of these grasslands.

The first survey, dominated by 34% *Elymus elongatus*, 15% *Seseli tortuosum* and 10% *Melilotus albus*, indicates excess humidity during some periods of the year.

Table 1

The floristic composition of the grasslands of the Chituc marine sandbar

No.sp.	Species	Relevee no.			Average %
		1	2	3	
	Vegetation coverage(%)	95.6	78.3	51.5	75.1
	***Poaceae* family species**				
1	*Elymus elongatus*	34.0			11.3
2	*Elymus farctus*	10.0			3.3
3	*Apera spica venti*	0.5			0.2
4	*Chrisopogon gryllus*		15.0		5.0
5	*Bromus sterilis*		1.0		0.3
6	*Bromus hordeaceus*		0.5		0.2
7	*Calamagrostis epigeios*		0.1		0.1
	***Fabaceae* family species**				
8	*Melilotus albus*	10.0			3.3
9	*Lotus tenuis*	3.0			1.0
10	*Medicago lupulina*			5.0	1.7
11	*Astragalus varius*			0.5	0.2
	Species from other families				
12	*Seseli tortuosum*	15.0	2.0		5.7
13	*Gypsophilla perfoliata*	10.0	0.5		3.5
14	*Euphorbia seguieriana*	5.0	15.0	15.0	11.7
15	*Centaurea arenaria*	2.0	1.0	2.0	1.7
16	*Scabiosa argentea*	2.0	7.0	0.5	3.2
17	*Silene borysthenica*	2.0	0.5	2.0	0.8

18	*Crepis foetida*	1.0	0.1		0.4
19	*Conyza canadensis*	0.5			0.2
20	*Astrodaucus littoralis*	0.5			0.2
21	*Asparagus littoralis*	0.1			0.1
22	*Scirpoides holoschoenus*		15.0		5.0
23	*Plantago maritima*		5.0		1.7
24	*Juncus maritimus*		5.0		1.7
25	*Inula salicina*		5.0		1.7
26	*Teucrium pollium*		3.0		1.0
27	*Dianthus polymorphus*		2.0		0.7
28	*Linaria genistifolia*		0.5	2.0	0.8
29	*Rumex crispus*		0.1		0.1
30	*Artemisia tschernieviana*			16.0	5.3
31	*Linum austriacum*			5.0	1.7
32	*Teucrium chamaedryis*			3.0	1.0
33	*Convolvulus lineatus*			0.5	0.2

The absence of the species *Puccinellia distans* ssp. *limosa* and *Juncus gerardii* from the Chituc sand dunes grasslands indicates a lower degree of soil salinization compared to the Periteașca - Leahova Sandbar.

The vegetal layer of these grasslands is better consolidated, with an average coverage of almost 78%, being 3% higher than on Chituc Sandbar. The share of forage and harmful species in the vegetal layer reflects the advanced stage of degradation of these grassland (Table 3). On average, the proportion of forage species is 19.6%, higher in Chituc (22.5%) and lower in Periteașca - Leahova (16.6%), here the highest proportion of harmful species being also recorded (61.1%).

The highest production of green fodder was estimated on the Chituc Sandbar grasslands, being almost 3 t/ha, which allows an average load of 0.35 LU/ha in the 130-day optimal grazing season. Being dominated by species with a smaller habitus, a production of 0.68 t/ha was estimated on the Periteașca - Leahova Sandbar, 4.5 times lower than on Chituc, which allows a very low livestock load of 0.08 LU/ha. The average pastoral value for these meadows was barely 11.5, which allows the production of 910 liters of cow's milk per hectare in 130 days of grazing season, with a load of 0.22 LU/ha or, more clearly expressed, almost one dairy cow per 5 hectares of grassland. With the present floristic composition, on the Chituc Grind can be obtained a quantity of 1,040 liters of milk per hectare and on the Periteașca - Leahova Grind 25% less, respectively 780 liters per hectare.

Observations made during field trips showed that although it is a completely protected area, the anthropogenic impact is more pronounced in the Periteașca - Leahova Sandbar, this being mainly due to the extensive, irrational grazing, which is allowed both for domestic animals - cows, and especially for animals that have escaped from control - wild horses. Therefore, an interesting phenomenon, highly appreciated by tourists, namely herds of horses running free, tends to become a problem that can endanger the integrity of the vegetation and even the survival of some emblematic plant species. For the future, taking into consideration the optimal livestock load assessments based on floristic surveys and the appropriate duration of the grazing season, limited in this area by extended drought, can substantially improve the phytodiversity of the evaluated areas.

Table 3

Productivity and grazing capacity of grasslands located on marine sand dunes in the Danube Delta

andbar	Floristic composition structure (%)		Green fodder production		Optimum load in 130 days (LU/ha)	Pastoral value (ind.)	Cow milk production	
	Forage	Harmful	t/ha	%			L/ha	%
1. Chituc	22.5	52.6	2.99	163	0.35	13.1	1040	114
2. Periteașca - Leahova	16.6	61.1	0.68	36	0.08	9.8	780	86
Average	19.6	56.8	1.84	100	0.22	11.5	910	100

Table 2

The floristic composition of the Periteașca - Leahova marine sand dunes

No.sp.	Species	Relevee no.										Average(%)
		1	2	3	4	5	6	7	8	9	10	
	Vegetation coverage (%)	86	80	100	86	71	100	75	51	47	81	77.7
	***Poaceae* family species**											
1	*Bromus tectorum*	10.0	19.0		15.0	10.0			10.0	15.0		8.0
2	*Cynodon dactylon*	1.0	3.0		0.5	3.0	3.0	2.0		0.5		1.3
3	*Puccinellia distans spp limosa*		0.5	2.0	5.0			3.0				1.1
4	*Bromus secalinus*			1.0								0.1
5	*Puccinellia festuciformis*					3.0	3.0					0.6
6	*Bromus sterilis*						5.0				20.0	2.5
7	*Phragmites australis var humilis*									0.1		0.1
	Fabaceae family species											
8	*Medicago minima*	3.0	0.5		1.0	0.1					2.0	0.7
9	*Trifolium campestre*						0.5		0.5		2.0	0.3
10	*Medicago falcata*						0.1					0.1
11	*Medicago lupulina*							1.0				0.1

12	*Vicia cracca*							0.5				0.1
	Species from other families											
13	*Juncus maritimus*	35.0	15.0	71.0	20.0		45.0	33.0			0.1	22.0
14	*Draba verna*	5.0	2.0	5.0	10.0	2.0	2.0	2.0			2.0	3.0
15	*Artemisia santonicum*	5.0	5.0	7.0	10.0	3.0	7.0	5.0	5.0	3.0		5.0
16	*Silene conica*	5.0			2.0							0.7
17	*Gypsophilla perfoliata*	3.0	2.0	3.0	2.0	1.0	3.0	5.0				1.9
18	*Senecio vernalis*	3.0	1.0		1.0	0.5	1.0	2.0	5.0	5.0		1.9
19	*Verbascum banaticum*	3.0	3.0		0.5	1.0		1.0	2.0		1.0	1.2
20	*Minuartia viscosa*	3.0	2.0	0.5				2.0				0.8
21	*Myosotis stricta*	2.0		3.0	7.0			2.0				1.4
22	*Plantago lanceolata*	2.0	1.0				0.5	1.0			2.0	0.7
23	*Limonium gmelinii*	2.0	1.0	2.0	2.0	5.0	3.0	2.0				1.7
24	*Centaurea arenaria*	2.0	1.0		1.0	1.0		1.0			0.1	0.6
25	*Euphorbia seguieriana*	0.5	2.0			0.5					5.0	0.8
26	*Teucrium scordium*	0.5				1.0		1.0		0.5	7.0	1.0
27	*Linum austriacum*	0.5	0.5		1.0							0.2
28	*Eryngium campestre*	0.1	0.5									0.1
29	*Elaeangus angustifolia*	0.1	15.0	0.5				2.0				1.8
30	*Schoenus nigricans*		3.0		3.0	5.0	5.0	5.0				2.1
31	*Syrenia cana*		2.0									0.2
32	*Carex colchica*		0.5	5.0	0.5	0.5	1.0	2.0				1.0
33	*Gallium humifusum*		0.5									0.1
34	*Onosma arenaria*		0.1									0.1
35	*Sonchus arvensis*		0.1		5.0							0.5
36	*Cichorium intybus*			0.5								0.1
37	*Juncus effusus*					18.0						1.8
38	*Cirsium arvense*					5.0						0.5
39	*Polygonum maritimum*					3.0						0.3
40	*Carex distans*					3.0						0.3
41	*Myosotis arvensis*					2.0	1.0					0.3
42	*Linaria genistifolia ssp euxina*					2.0	2.0	1.0				0.5
43	*Stachys recta*					1.0						0.1
44	*Senecio vulgaris*					0.5						0.1
45	*Juncus gerardii*						17.0					1.7
46	*Galium aparine*						2.0			0.5		0.3
47	*Cirsium vulgare*							2.0		2.0		0.4
48	*Xanthium strumarium*								13.0	10.0		2.3
49	*Rumex dentatus*								7.0	2.0	2.0	1.1
50	*Alyssum minutum*								5.0	5.0	17.0	2.7
51	*Argusia sibirica*								2.0	2.0		0.4
52	*Glaucium flavum*								1.0			0.1
53	*Crambe maritima*								0.1			0.1
54	*Ceratocarpus arenarius*									1.0		0.1
55	*Polytrichum sp (mușchi)*										20.0	2.0
56	*Taraxacum besarabicum*										1.0	0.1

CONCLUSIONS

The permanent grasslands located on the sandbars of the Danube Delta are in a stage of low productivity due to the existence of 22-25% gaps in vegetation and a low participation, of only 17-23%, of forage species in the vegetal layer. The production of green fodder was evaluated at 0.68 t/ha on the Periteașca - Leahova Sandbar and 3 t/ha on the Chituc Sandbar, allowing a livestock load of 0.08-0.35 LU/ha in an optimal grazing season of 130 days.

The average pastoral value is 11.5, which allows for an average production of 910 liters of milk per hectare, respectively 1040 l/ha on the Chituc Sandbar and 780 l/ha on the Periteașca - Leahova Sandbar. Taking into consideration the optimal annual grazing period and grassland's carrying capacity can be important measures for the efficient management of sand dunes vegetation and can contribute to the conservation of biodiversity and also to enhance the productivity of these sensitive areas.

REFERENCES

1. Făgăraş, M., Gomoiu, M. T., (..) & Cogalniceanu D. (2008a) *Strategy for the conservation of coastal biodiversity of Dobrogea*. Ed. Ex Ponto, Constanta.
2. Făgăraş, M., Skolka, M., Anastasiu, P., Cogălniceanu, P., Negrean, G., Bănică, G., & Samoilă, C. (2008b) The biodiversity of the coastal area of Dobrogea between Cape Midia and Cape Kaliacra. Edit. Ex Ponto, Constanta.
3. Fagaras, M. (2015) Embryonic shifting dunes on the Romanian Black sea coast. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series*, *45*(1), 306-313.
4. Făgăraş, M., Niculescu, M., & Popoviciu, R. (2015) Annual vegetation along the Black Sea shoreline within the Danube Delta Biosphere Reserve. *Conference proceedings of the 15th International Multidisciplinary Scientific Geoconference SGEM* (Vol. 3, No. 2, pp. 595-602).
5. Doroftei, M., Oprea, A., Ştefan, N., & Sârbu, I. (2011). Vascular wild flora of Danube Delta biosphere reserve. *Sci. Ann. Danube Delta Inst.(Tulcea)*, *17*, 15-52.

6. Doroftei, M., & Covaliov, S. (Eds.) (2013) „Handbook of... Danube Delta", Guide for field staff of the Danube Delta Biosphere Reserve Administration and Environmental Guard, Edit. Danube Delta Technological Information Center, Tulcea, 482.
7. Hanganu J., Dubyna D., Zhmud E., Grigoras¸ I., Menke U., Drost H., Stefan N., and Sarbu, I. (2002) Vegetation of the Biosphere Reserve "Danube Delta" - with Transboundary Vegetation Map on a 1:150,000 scale. Danube Delta National Institute, Romania; M.G. Kholodny - Institute of Botany & Danube Delta Biosphere Reserve, Ukraine and RIZA, The Netherlands. RIZA rapport 2002.049, Lelystad.
8. Marușca T., Blaj V. A., Mocanu V., Andreoiu Andreea C., Zevedei P. M. (2018) Long term influence of botanical composition of alpine pastures on cow milk production, Proceedings of the 27th General Meeting of the European Grassland Federation, EGF, Volume 23, Pp. 283-285, Cork, Ireland, 17-21 iunie, ISBN 978-1-84170-643-6
9. Marușca T. (2019) *Contributions to the evaluation of pasture productivity using the floristic releve*, Romanian Journal of Grassland and Forage Crops Nr. 19, Cluj – Napoca, pp. 33- 47.
10. Marușca T. (2022) *Praticultură și pastoralism în cercetarea științifică*, Editura Universității *„*Transilvania*"* din Brașov
11. Marușca T. (2023) *The productivity assessment of the vegetation of the saline grasslands in Romania*, Academy of Romanian Scientists Series on Agriculture, Silviculture and Veterinary Medicine Sciences, Volume 12, Number 1, pp. 46-51
12. Marușca T., Andreoiu C. A., Dragoș M. M., Comșia C. C., Porr I. C. (2024) *Contributions to the assessment of the productivity of fourage grass vegetation in the Danube Delta*, Romanian Journal of Grassland and Forage Crops , Cluj Napoca, nr.29 pp. 71-84, ISSN 2068-3065,
13. Mueller-Dombois, D., Ellenberg, H. (1974). Aims and methods of vegetation ecology. *John Wiley & Sons*.
14. Oprea A., Marușca T. (2022) *Contribution to the assessment of mountain grasslands productivity from Râmnicu Sărat River Basin*, Academy of Romanian Scientists Series on Agriculture, Silviculture and Vet. Medicine Sciences, Volume 11, Number 1, pp. 50-61,
15. Munteanu I., Curelariu Gh. (1996) Soil Map, Romanian Danube Delta Biosphere Reserve, 1:100000, Tulcea: Danube Delta National Institute for Research and Development, Lelystad: Directorate General for Water Management and Public Works of the Netherlands.

16. Petrescu, M. (2007) *Dobrogea and Danube Delta: conservation of flora and habitats*. Eco-Muzeal Research Institute, Tulcea.
17. Popescu A., Sanda V., Oroian Silvia, Chifu Th., Ștefan N., Sârbu I.(1997) *The vegetation of Danube Delta,* Mureș County Museum, *Marisia*, XXV, Studies and supplementary materials, Târgu Mureș
18. Porea, D., & Gorgan, D. L. (Eds.), (2022). Handbook on biodiversity conservation and monitoring of endangered species. Edit. Danube Delta Technological Information Center, Tulcea.
19. Sanda, V., Öllerer, K., & Burescu, P. (2008). *Phytocoenoses in Romania: syntaxonomy, structure, dynamics and evolution*. Ars Docendi, Bucuresti.

THE TROPHIC CONDITIONS FOR AGRICULTURAL CROPS FROM THE VELJURILOR PLAIN

Octavian BERCHEZ [1], MINTAȘ Olimpia Smaranda[1] and STANCIU Alina Ştefania*[1]

1Faculty of Environmental Protection, University of Oradea, 410048, Oradea, Romania;
oberchez@uoradea.ro
olimpia.mintas@uoradea.ro, , astanciu@uoradea.ro

*Corresponding author. E-mail: astanciu@uoradea.ro

ABSTRACT

The research was carried out over a period of 5 years (2019 – 2023), with the aim of determining and transposing on the map the soil taxonomic units of the Veljurilar Plain, quantifying the existing trophic conditions, cataloging the limiting and restrictive factors of agricultural production and establishing the main intervention directions for optimally ensuring the conditions for growth, development and fruiting of agricultural crops. In order to establish and determine the soil taxonomic units existing in the territory, their spatial extension and their transposition on the map, 60 main soil profiles, 120 secondary profiles and 220 control profiles were executed in the field. To determine the chemical parameters of the soils, 360 soil samples were taken and analyzed. The analyzes of the chemical parameters of the soils were carried out by spectrophotometry. The following were studied and quantified: the time variation of climatic parameters (air temperature, soil temperature, precipitation, relative air humidity, air current movements) and soil trophic conditions (nutrient content, current acidity – pH value, excess of moisture from precipitation, excess groundwater). Based on the results of the research, the limiting and restrictive factors of agricultural production were established and the main directions of intervention were drawn to ensure optimal trophic conditions for the growth, development and fruiting of agricultural crops: measures to conserve water in the soil and measures to increase soil fertility potential. The results of current research can be stored in data banks, which can be retrieved and used in agricultural practice by economic units with an agricultural profile. The research can be integrated into the National Soil Quality Monitoring System, within the International Environmental Quality Monitoring System.

Keywords: trophic conditions; climatic regime; so il types; fertility; limiting factor

INTRODUCTION

The research was carried out with the aim of establishing the soil units of the Veljurilor Plain and to know in detail the trophic conditions for agricultural crops in the Veljurilor Plain, to quantify the limiting and restrictive factors of agricultural production and to establish the main directions of intervention and impact limitation generated by these factors.

Changes in the elements of the climate regime: air temperature, soil temperature, precipitation, relative air humidity and air current movements, have determined considerable decreases in agricultural production. The quantification of climatic parameters will allow a better zoning and rotation of agricultural crops, as well as the choice of the assortment of agricultural crops with a high degree of adaptability [1]. The identification and evaluation of the restrictive and limiting factors of agricultural production and the measures that are required to limit the impact on production, constitute the main mechanism for sustainable agriculture [2,3].

The integrated research of the conditions for the development of agricultural crops in a certain area, the establishment and quantification of the limiting and restrictive factors of agricultural production and the establishment of the main directions of intervention to ensure the optimal conditions for the development of crop plants, are the basis of the practice of sustainable agriculture.

Geographically, the Veljurilor Plain is located in N-W Romania, being a subunit of the Crișurilor Plain (Figure 1, 2). Within the Crișurilor Plain, it occupies an area of 21088.1 ha, located in the central part. From a territorial and administrative point of view, the area of Câmpia Veljurilor overlaps territorially with the localities of Tinca, Tulca, Mădăras, Cefa, Gepiu, Sânicolau Român, Nojorid, Toboliu, Girişu de Criş, Sântandrei.

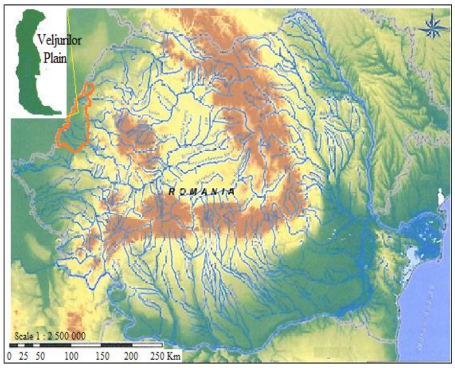


Fig. 1. Veljurilor Plain. Geographical location

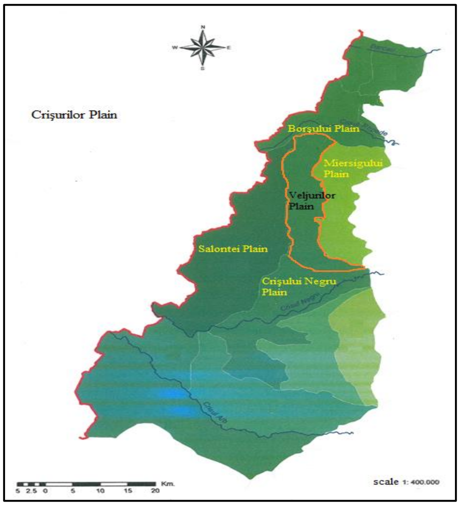


Fig. 2. Veljurilor Plain, subunit of the Crișurilor Plain (Posea, 2006)

The altitude of the plain is between 100 and 150 m. The climate regime is characterized by average annual temperatures of 11.7 °C and average annual precipitation of 650 mm (average values over the last 50 years) [4]. The distribution of precipitation during the year is uneven, presenting monthly variations.

Moisture deficit in the soil is recorded in the months of June - September, the frequency of drought periods being high in years with deficient amounts of precipitation. The parent materials on which the soil units were formed and evolved are represented by: loess, loessoid deposits, clays, marls, alluvial deposits. Surface deposits are represented by fluvial deposits, deluvial deposits, proluvial deposits, deluvial-proluvial deposits and marsh deposits (Figure 3) [5,6, 7]. The water table is generally located at depths greater than 5.5 m and presents a low degree of mineralization. In the low areas of the plain (in the area of the localities of Toboliu, Cheresig, Cefa, Inand, Homorog, Ianoșda) the groundwater is concentrated at depths of less than 3.5 m, influencing the physical-chemical and biological properties of the soils.

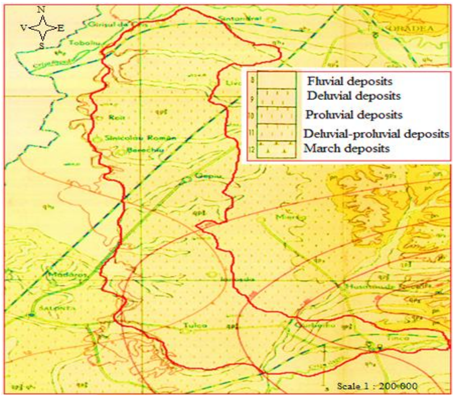


Fig. 3. The Map of surface deposits in the Veljurilor Plain

MATERIALS AND METHODS

The study was carried out over a period of 5 years: 2019 – 2023. The climatic parameters were studied and interpreted based on the meteorological data provided by the Bucharest National Meteorological Administration, Oradea Meteorological Station [12]. The following climatic parameters were taken into study: air temperature, soil temperature, precipitation, relative air humidity and air current movements. The research, the identification, spatial delimitation and mapping of soil taxonomic units was carried out by researching a number of 60 main soil profiles, 120 secondary profiles and 220 control profiles [8,9]. The identification of soil taxonomic units was carried out at the level of class, type and subtype of soil based on the Romanian Soil []. Taxonomy System 2012+ (SRTS - 1012+) [10], later being transposed into the World Reference Base for Soil Resources (WRB-SR-1998) [11]. In order to establish the fertility potential of the soils, they were sampled a number of 360 soil samples, at 2 depths: 0 - 15 cm, respectively 15 - 30 cm. Analyzes were performed on current acidity (pH), total nitrogen, mobile phosphorus, mobile potassium[13].

The analyzes of the chemical parameters of the soils were carried out by spectrophotometry. The analyzes were carried out in the Pedology Laboratory of the Faculty of Environmental Protection, University of Oradea. The methods of analysis of agrochemical indicators, data processing and interpretation were carried out according to the standards and methodology developed by the National Institute for Pedology, Agrochemistry and Environmental Protection - ICPA Bucharest [8].

RESULTS AND DISCUSSION

The growth, development and fruiting of plants, presupposes the existence of appropriate vegetation conditions for the crops, by ensuring at an optimal level all the ecological factors that have a decisive effect on the level and quality of agricultural production. High yields can only be obtained through simultaneous and complex interventions on vegetation factors, one cannot intervene unilaterally, and the problems must be solved through appropriate interventions.

Soils of the Veljurilor Plain

The research, identification and spatial delimitation of soil taxonomic units belonging to the Veljurilor Plain was carried out in the period 2019-2022 (9), by carrying out a number of 60 main soil profiles, 120 secondary profiles and 220 control profiles. Following field research and subsequent correlation with laboratory results, 7 soil types were identified, surveyed and mapped in accordance with the World Reference Base for Soil Resources (WRB-SR-1998) [11]. After carrying out the pedological mapping works, the Map of the soil units of the Veljurilor Plain was created (Figure 4). Table 1 shows the soils of the Veljurilor Plain by territorial administrative units, soil types and surfaces [11].

Table 1.

Soils of the Veljurilor Plain by territorial administrative units, soil types and surfaces (World Reference Base for Soil Resources).

Soil type	Distribution area	Area - Ha
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9
Surfaces occupied by water, canals		56,1
Total agricultural area		12697,9
Areas of land occupied by constructions, roads		8391
TOTAL AREA		21.088,1

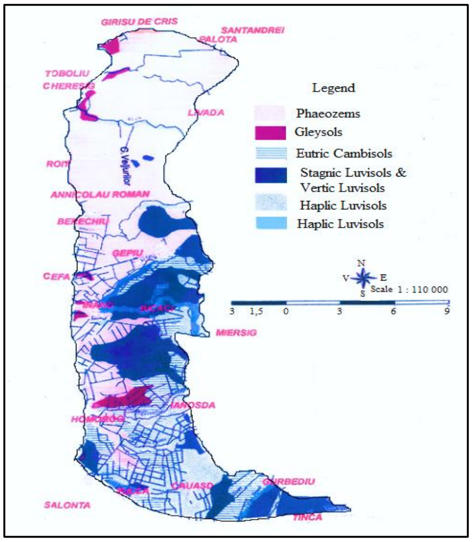


Fig. 4. Soil map of Veljurilor Plain

Limiting factors of agricultural production

Annually, in the Veljurilor Plain, agricultural production depends on and is under the influence of restrictive or limiting factors that manifest themselves with different intensities and condition the quality and level of the harvest. Monitoring and knowing the causes that generate them makes it possible to intervene to remedy the intensity of manifestation or remove the restrictive factor [15,17]. The main limiting or restrictive factors of agricultural production in the Veljurilor Plain are represented by: elements of the climate regime; excess moisture from precipitation; excess phreatic moisture [25]; current soil acidity (pH); low content in nutritional elements.

Climate regime

The climatic parameters were studied and interpreted on the basis of meteorological data provided by Bucharest National Meteorological Administration, Oradea Meteorological Station [12].

Air temperature

The average annual temperature for the entire duration of the research (2019 – 2023) was 12.4°C. There is an increase in the annual average temperature by 0.7°C compared to the average of the last 50 years (11.7°C). The highest value was presented in 2019 - +12.9°C and the lowest in 2021 - +11.6°C. Table 2 shows the average annual temperature values for the period 2019 –2023. Table 3 Shows the average monthly temperatures for the period 2019 –2023.

Table 2

Averange annual temperaturesfor the period 2019 – 2023

The year	Medium temperature annually	The minimum value registered	Maximum value recorded
2019	+12,9	-12,1 – 08.01.2019	+36,1–02.08.2019
2020	+11,9	-8,8 – 08.01.2020	+34,9 – 30.08.2020
2021	+11,6	-13,3 – 16.01.2021	+37,1 – 16.08.2021
2022	+12,3	-13,9 – 12.01.2022	+38,7 – 23.07. 2022
2023	+13,2	-8,2 – 10.02.2023	+36,9 – 28.08.2023

Table 3

Average monthly temperatures for the period 2019 –2023

Month	Medium value	The minimum value registered	Maximum value recorded
January	+0,9	-13,9– 12.01.22	+14,9 – 01.01.23
February	+3,8	-12,9 – 13.12.21	+18,0 – 03.02.19
March	+6,8	-16,7 – 12.03.22	+20,9 – 31.03.19
April	+10,5	-3,1 – 01.04.20	+28,6 – 26.04.19
May	+15,5	+2,3 – 04.05.21	+28.4 – 11.05.21
June	+21,5	+6,3 – 02.06.20	+37,2 – 30.06.22
July	+23,1	+8,6 – 10.07.19	+38,7 – 23.07.22
August	+23,4	+10,2 – 19.08.21	+37,1 – 16.08.21
September	+18,3	+2,9 – 23.09.21	+32,7 – 01.09.19
October	+13,2	-0,9 – 08.10.23	+27,2 – 21.10.23
November	+7,4	-3,8 – 27.11.23	+23,9 – 04.11.21
December	+3,9	-7,0 – 23.12.21	+18,0 – 02.12.23

Table 4 shows the average monthly temperatures, according to years of research.

Table 4

Average monthly temperatures by years of research

Month	Medium value				
	2019	2020	2021	2022	2023
January	-0,9	-1,4	+1,8	-0,5	+5,4
February	+3,9	+4,6	+3,7	+4,4	+2,3
March	+8,7	+7,2	+5,0	+5,3	+7.9
April	+13,4	+11,2	+8,8	+9,7	+9,7
May	+14,8	+14,4	+14,6	+17,2	+16,8
June	+22,7	+20,0	+22,0	+22,9	+20,1
July	+21,5	+21,3	+24,9	+24,0	+23,7
August	+24,0	+23,3	+21,8	+24,2	+23,7
September	+18,1	+19,1	+17,3	+16,1	+21,0
October	+13,7	+12,9	+11,0	+12,9	+15,4
November	+10,9	+5,2	+6,5	+7,6	+6,9
December	+4,2	+4,9	+2,0	+4,0	+4,2

The average monthly temperature recorded the lowest values in January 2020 of -1.4℃ and the highest values in July 2021, +24.9℃. Figure 5 shows the average monthly temperatures during the bioactive period (March – October). Table 5 shows the average monthly temperatures recorded for the period from June to September, the period in which soil moisture deficit is frequently recorded.

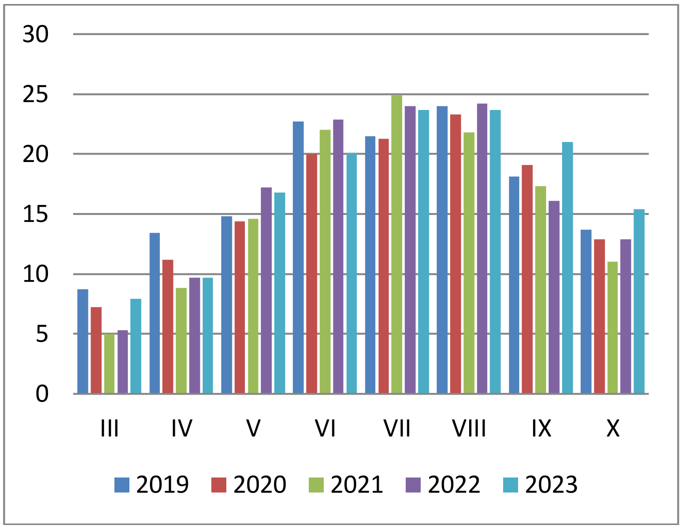


Fig. 5. Graph of average monthly temperatures recorded during the bioactive period March – October (2019 – 2023).

Table 5

Average monthly temperatures recorded for the period June-September, 2019 - 2023

Month	Monthly average temperature				
	2019	2020	2021	2022	2023
June	+22,7	+20,0	+22,0	+22,9	+20,1
July	+21,5	+21,3	+24,9	+24,0	+23,7
August	+24,0	+23,3	+21,8	+24,2	+23,7
September	+18,1	+19,1	+17,3	+16,1	+21,0

The highest average monthly temperatures were recorded in 2022 and the lowest in 2020. Figure 6 shows the average monthly temperatures recorded in the months of June - September (2019 - 2023), an interval characterized by the high frequency of drought periods.

Soil temperature

It depends on the amount of energy received from the sun, the thermophysical properties of the soil, the forms of macro and microrelief, the exposure, the type and presence of the vegetal carpet, the presence or absence of the snow cover, the morphological characteristics of the soil [26,31].

The multiannual average temperature recorded at the soil surface, for the period 2019 - 2022, was 11.64°C. Average monthly temperatures recorded at the soil surface are presented in Table 6.

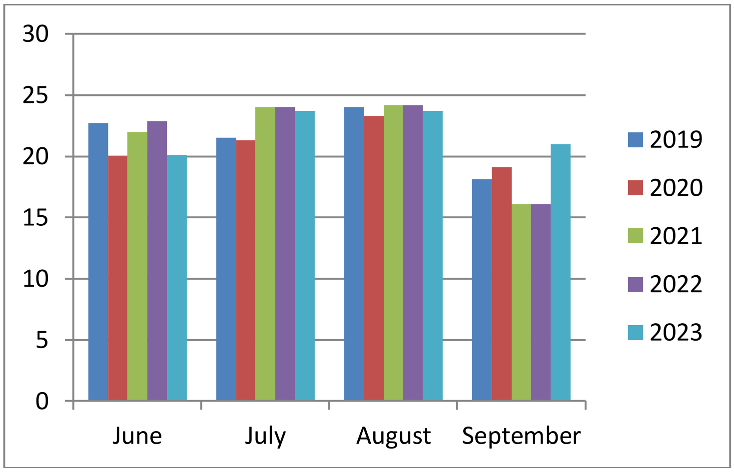


Fig. 6. Graph of average monthly temperatures

Table 6

Average monthly temperatures recorded at the soil surface (°C)
for the period 2019 – 2023

Oradea Weather Station	
Month	Recorded values - °C
January	-1,1
February	0,4
March	5,5
April	11,9
May	19,2
June	23,0
July	24,6
August	23,5
September	17,2
October	10,8
November	4,4
December	0,3

Precipitation

For the period 2019 - 2023, the average annual value of precipitation was 820.4 mm, a value higher than the average calculated for the last 50 years, of 650 mm. The amount of precipitation recorded values between 667 mm in 2021 and maximum values of 945 mm in 2020.

Table 7 shows the annual amounts of precipitation recorded for the period 2019 - 2023.

In the table 8 shows the recorded monthly rainfall, by research years: 2019, 2020, 2021, 2022 and 2023.

Table 7

The amount of annual precipitation recorded during the period 2019 – 2022

Period	Total amount of precipitation	Maximum value recorded - date	Share of days with precipitation
2019	835 mm	60,0 mm în 12 h 27.06.2019	158
2020	945 mm	39,9 mm în 6 h 22.06.2020	138
2021	667 mm	22,0 mm în 12 h 11.07.2021	150
2022	752 mm	27,0 mm în 12 h 02.09.2023	150
2023	903 mm	41,0 mm in 12h 12.07.2023	167

Table 8

Recorded monthly precipitation, by research years: 2019, 2020, 2021, 2022 and 2023

Month	Recorded monthly precipitation - mm				
	2019	2020	2021	2022	2023
I	92	25	86	24	68
II	17	75	76	31	36
III	23	65	28	19	42
IV	81	26	51	79	54
V	183	110	117	36	63
VI	182	182	6,2	40	65
VII	38	172	47	104	96
VIII	25	47	37	29	88
IX	55	46	12	213	79
X	17	102	6	6	44
XI	53	27	79	79	140
XII	65	68	92	93	129

For the entire research period 2019 – 2023, the highest values of precipitation amounts were recorded in September 2022, being 213 mm, and the lowest values in October 2021 and October 2022 - 6 mm.

Figure 7 shows the precipitation graph by months and years of research. Precipitation from the bioactive period March - October recorded an average of 67.87 mm, the lowest values were recorded in 2021 - 38.02 mm, and the highest in 2020 - 93.75 mm. Table 9 shows the precipitation values from the bioactive period March - October.

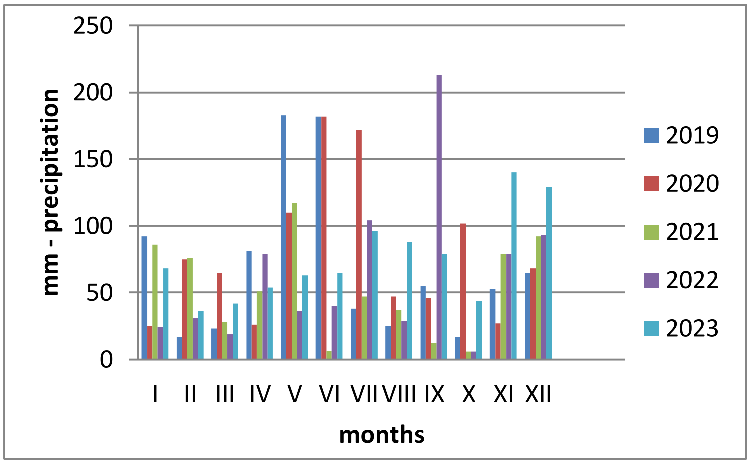


Fig. 7. Precipitation graph by months and years of research.

Table 9

Precipitation values from the bioactive period March – October

Period	Recorded monthly precipitation - mm				
	2019	2020	2021	2022	2023
March - October	75,5	93,75	38,02	65,75	66,4

In Figure 8, the rainfall values from the bioactive period are graphically presented, by months and years of study. The frequency of drought periods was high during the interval June - September.

Table 10 shows the amount of precipitation recorded in the period June - September, 2019 - 2023. Figure 9 represents the precipitation graph for the period June - September, 2019 - 2022

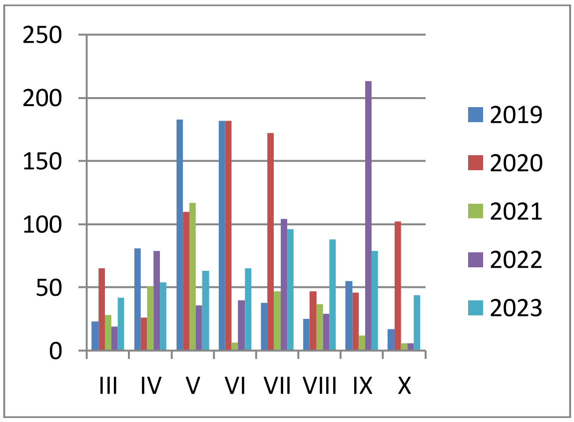


Fig. 8. Precipitation graph from the bioactive period March - October, by months and years of study

Table 10

The amount of precipitation recorded in the period
June - September by years of research

Period	The amount of precipitation	Maximum value (date)	The proportion of days with precipitation
2019	300 mm	60.0 in 12 h (27.06)	43
2020	447 mm	39.0 in 6 h (22.06)	44
2021	102 mm	22.0 in 12 h (11.07)	32
2022	386 mm	27.0 in 12 h (22.09)	49
2023	307 mm	41.0 in 12 h (12.07)	44

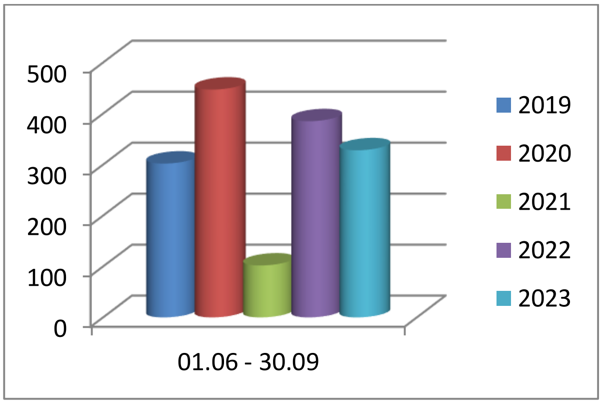


Fig. 9. Graphic representation of rainfall amounts for the period June - September, 2019 – 2022

The relative air humidity expressed in %, at 2 m above the ground, for the period 2019-2023, is presented in Table 11. The lowest values of the relative humidity of the air were recorded in 2022, between June - September.

Table 11

Relative air humidity expressed in %, at 2 m above the ground, for the period 2019 – 2023 (medium values)

Month	2019	2020	2021	2022	2023
I	87	90	85	83	85
II	76	74	81	74	79
III	60	65	64	51	70
IV	62	50	69	68	72
V	70	66	72	63	70

VI	66	77	60	55	70
VII	62	72	61	50	64
VIII	61	63	62	59	65
IX	62	64	64	78	63
X	74	82	66	80	66
XI	86	90	84	89	83
XII	86	85	88	87	85

Movements of air currents

In the area of Veljurilor Plain, air currents in the East and South direction had the highest frequency, with values of 19.6% in the East direction and 13.5% in the South direction.

Table 12 shows the cardinal direction of air currents and frequency, for the entire study period 2019 –2023. Figure 10 shows the direction and frequency of air currents for the period 2019 - 2023.

Table 12

Cardinal direction of air currents and frequency, for the entire study period 2019 –2023

Direction	N	NNE	NE	ENE
Frequency	9.5 %	6.8 %	3.3 %	3.3 %
Direction	S	SSW	SW	WSW
Frequency	13.5 %	6.6 %	4.4 %	3.2 %
Direction	E	ESE	SE	SSE
Frequency	19.6 %	6.8 %	3.5 %	4.0 %
Direction	W	WNW	NW	NNW
Frequency	4.3 %	2.7 %	3.5 %	4.9 %

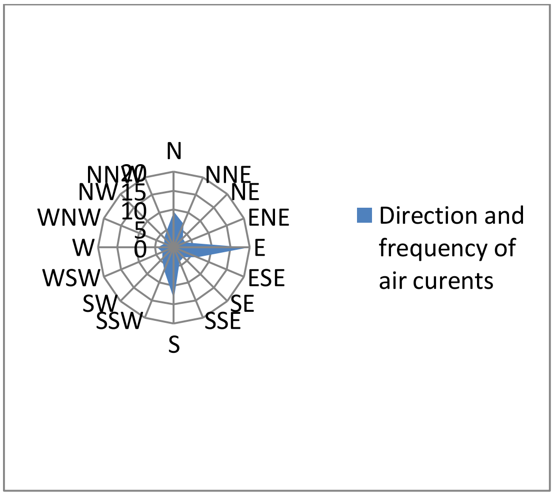


Fig. 10. Graphic representation of the cardinal direction of air currents and frequency, during the period 2019 –2023

In the Veljurilor Plain, the main limiting factor of agricultural production is represented by the rainfall regime. Following the monitoring of the precipitation regime over a period of 5 years, the results showed that periods of drought occur with a high frequency between the months of June – September [14].

Through the set of measures that are imposed, it is aimed that the soil stores the entire amount of water from the precipitation. This can be achieved through the practice of sustainable agriculture, so that through crop maintenance works a good conservation of soil water is ensured, preventing all ways of non-productive water loss [22]. On the 0-120 cm layer, water losses of 835 t/ha were recorded on the unplowed land and 181 t/ha on the summer plowed land [23].

Raising the fertility potential through the use of chemical and organic fertilizers improves the structuring state of the soils, increases the humus content and water retention in the soil for a longer period. The use of organic fertilizers increases the water storage capacity by 20%, humus retains 6 times more water, delaying the onset of drought by two weeks in periods of insufficient rainfall. Reducing water losses can also be done by reducing the degree of weeding of crops, weeds are large consumers of water [27].

Another effective method consists in cultivating earlier species and varieties (hybrids), with lower specific water consumption and which make good use of the little water available in the soil (specific consumption for millet is 311 mm, for sorghum 322 mm). Sowing at the optimal time for the plants to grow and develop normally in the early stages, without the water stress that occurs later, when the plants are less affected, helps to combat the effects of early drought [18]. At the same time, the density at sowing should be correlated with the existing water reserve in the soil and in the case of drought forecasts, lower densities should be ensured. Periodic checking of the water reserve of the soil, knowing that a reserve of 100 – 150 mm at a depth of 0 – 90 cm ensures the development of plants for a maximum period of 2 months. The most effective method of combating the effects of drought is the establishment of irrigation systems[19,28,33].

Excess moisture from precipitation

In the Veljurilor Plain, the excess rain moisture affects a total area of 3808.4 ha of agricultural land, in the localities: Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român. Soil surfaces affected by excess rain moisture are found with preference, on relief units with poor natural drainage, land surfaces are practically horizontal or very slightly inclined, covered with fine deposits, very little permeable (from terraces and high plains), such as in closed valleys or micro depressions that favor the accumulation and stagnation of water from precipitation [20].

The parental material of these soils is represented, as a rule, by deluvial-proluvial clays of Pleistocene age, which sometimes cover (a few meters deep) torrentially stratified gravels and sands. They can also appear on recent alluvial or deluvial-proluvial clay deposits (in the relatively young parts of the plain). These soils are naturally occupied by pastures and hayfields, in the floristic composition plants with low or no fodder value predominate (Carex sp., Juncus sp.), [21]. The stagnation of water re-sulting from precipitation leads to the deterioration of the aerohydric regime and deter-mines changes in the physical and chemical properties of the soil, thus creating unsuita-ble conditions for the development and fruiting of plants by inhibiting the respiration of the roots and changes in the chemistry of the soil.

Soils with excess rain moisture are soils that fall into classes of reduced workability and trafficability, there are long periods of time in which it is not possible to carry out work on the establishment and maintenance of agricultural crops.

Due to the excess moisture recorded in the spring, a large part of the seeds that reached the soil no longer germinate (20-30%), the plants develop unevenly, the harvests are generally small and of poor quality. They are soils with low natural fertility, the aerohydric regime of the soil, unfavorable for the development of cultivated plants, the low microbiological activity and the low content of nutrients contribute to this. On these soils, in the spring period, due to the stagnant water, a surplus of moisture is recorded in the surface horizon, unsuitable conditions are created for the germination and normal development of crop plants, and in the summer period (when the precipitation is low) the plants feel a pronounced lack of water due to the accentuated drying of the upper horizons [20].

For these soils, a differentiated agricultural technique and measures to eliminate the excess water that appears in the spring are required. It is recommended to carry out deep plowing to mobilize the soil at a greater depth, thus an improvement of the aerohyric regime of the soil takes place. On soils strongly affected by water stagnation, special drainage measures are recommended. An effective measure to increase the fertility potential is the application of organic fertilizers and mineral fertilizers [24].

Excess phreatic moisture

The excess of groundwater affects an area of 550.9 ha, located in the localities: Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog. These soils that were formed in relief conditions where the hydrostatic level of the phreatic aquifer layer is between 1 m and a maximum of 2 (2.5) m deep. They are soils that are generally characterized by a sensitive accentuation of the state of subsidence, towards the base of the profile, where the underground water is permanently or temporarily.

The influence of groundwater in the formation of Gleysols is stronger, due to the water table level between 1 and 2 (2.5) m deep. The annual variation of the humidity state of these soils is determined by the oscillations of the phreatic level (the phreatic wetting due to the capillary ascent of water from the phreatic water) highlights the alternating-exudative nature of the water regime of these soils.

Groundwater is generally poorly mineralized (0.5 - 1.5 g/l soluble salts), predominantly bicarbonate, rarely sulfate, chalco-magnesian or chalcosodic [20]. Negative effects due to the defective aerohydric regime are felt from seed germination, anaerobic conditions prevent the germination and sprouting of plants, the roots grow weakly and penetrate shallowly into the soil, toxic products accumulate in plants that create disturbances and decrease the capacity to absorb water and mineral salts, the weakening of the plants and implicitly the decrease in production [19]. The improvement and full utilization of the fertility potential of these soils can be achieved by: drainage works associated with underground drainage works, deep plowing, the administration of calcareous amendmentson moderately and strongly acidic gleysols, the administration of organic and mineral fertilizers. After carrying out the entire complex of measures, the following can be successfully cultivated: corn, autumn cereals, sugar beets, sunflowers, fodder plants, etc. After carrying out the drainage works, the natural fertility of gleysols improves considerably, as a result of the improvement of the aerohydric regime and, respectively, of the activation of the mineralization processes of the organic substance [20] The administration of chemical fertilizers with nitrogen must be carried out with caution, considering the critical depth of the groundwater and the fluctuations of the water table in the soil profile that, are recorded during the course of a year. The use of high doses of nitrogen fertilizers can lead to the pollution of the groundwater with nitrites and nitrates.

Current acidity (pH value).

Acid soils, due to the current acidity and the physical, physico-chemical and bio-logical properties that characterize them, present a low natural fertility potential, un-suitable for the development and fruiting of crop plants in accordance with the genetic potential.These soils are characterized by values of current acidity lower than 6.2, degree of saturation in bases < 75%, low values of the sum of exchangeable bases, high values of hydrolytic acidity and the dominance in the absorptive complex of H^+ and A^{3+} ions. In acidic pH conditions by the solubilization of hydroxides of Al, Mn, Fe, Bo, there is an increase in the mobile forms of Al^{3+}, Mn^{2+}, Fe^{3+}, Bo^{3+} and a decrease in the content of soluble phosphates and Mo accessible to plants.Aluminum, in acid soils, is found in ionic form – Al^{3+}, having a toxic effect on plants. The toxic action of aluminum is felt by plants at concentrations of 15 – 20 ppm, while the minimum limit of the toxic concentration of Al^{3+} absorbed by plants is 1 ppm (Al accu-mulates in plants at the root level). It also determines the immobilization of phosphorus in non-assimilable compounds and the reduction of the concentration of the soil solution in $H_2PO_4^-$. The high concentration of mobile aluminum in the soil solution prevents the absorption of other cations with a role in plant nutrition: Ca^{2+}, Mg^{2+}, K^+, and NH_4^+. The most sensitive crops to high concentrations of mobile aluminum are: wheat, alfalfa, clover, sugar beet. Tolerance shows corn, potato and lupine. The negative action of Al^{3+} ions is reduced by the presence of Ca ions. Increasing the content of Mn^{2+} favors its accumulation in plants, the metabolism of protein substances and carbohydrates being disturbed (Mn accumulates in the aerial part of plants). The excess of Mn is much more toxic than that of Al, especially in sugar beet and leguminous plants.

The negative effects of the acid reaction are manifested in soils through a series of unfavorable physical properties, the soils presenting a structure with poor hydrostability or are devoid of structure.

In the Veljurilor Plain, out of the total cultivated area of 12,697.9 Ha, the area oc-cupied by soils with moderate and strong acidity is 10 023.1 Ha, being represented by the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols, Vertic Lu-visols. These soils occupy areas in the localities: Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Tinca. Table 13 shows the units of moderately acidic and weakly acidic soils and the area they occupy within the Veljurilor Plain.Most cultivated plants grow and bear fruit at a pH value between 6.4 and 7.8. At values of pH between 6.8 and 7.2, plants meet the most favorable nutrition conditions with macro and micro elements. At values below 6.4 and above 7.8, plants suffer from nutritional disorders due to the passage of the assimilable forms of the nutritional elements into hard to assimilate or inaccessible forms and the mobilization of some compounds with toxic action for plants.

Table 13

Moderately acid and weakly acid soils of the Veljurilor Plain

Soil type	Distribution area	Value pH	Interpretation	Value Ah	Surface ha
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	5,9 – 6,3	Moderately acidic - weakly acidic	1,4 -3,3	2 448,6
Haplic luvisols	Inand, Bicaci, Tulca, Gurbediu	5,9 – 6,2	Moderately acidic - weakly acidic	3,1 – 5,2	3 296,4
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	5,7 – 5,9	Moderately acidic	4,1 – 6,8	3 808,0
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	6,2 – 6,4	Weakly acidic	2,7 – 3,1	469,7
TOTAL AREA 10 023,1					

In acidic soils, the reduction of the negative effects due to the presence of high concentrations of Al^{3+}, Mn^{2+}, Fe^{3+} and H^{+} ions in the soil solution can be achieved by using chemical fertilizers with a physiological acid reaction, by administering organic fertilizers and the administration of calcareous amendments, in the form of calcium carbonate ($CaCO_3$) or calcium oxide (CaO).

Soils with a low content of nutrients

Soils with low and medium content in total nitrogen

The chemical analyzes carried out on the soils of the Veljurilor Plain, revealed values of the supply in total nitrogen, expressed in ppm, between 32 ppm and 110 ppm, values corresponding to a supply from low to medium supply. Average N input shows Phaeozems soil type with values between 84 ppm and 110 ppm total nitrogen. The low and average values of the total nitrogen supply (%) correspond to the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols. These soils have values between 32 ppm total nitrogen and 64 ppm. The total area occupied by soils with low and medium content in total N is 10.023 ha. Table 14 shows the nitrogen supply status of the soils of the Veljurilor Plain.

Table 14

Nitrogen supply status of the soils of the Veljurilor Plain

Soil type	Distribution area	Area - ha	Total N - ppm Medium values	Reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	52 – 64	medium
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	84 – 110	Medium-high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	36 – 64	Low-medium
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	35 – 62	Low-medium
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	32 – 57	Low-medium
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	72 – 86	medium

Soils with low and medium phosphorus content

Following the analysis of the mobile phosphorus content of the soils of the Veljurilor Plain, they present values between 4 and 74 ppm, values that correspond to a state of supply from very poor to a good supply.

A good phosphorus supply (between 38.3 – 74.2 ppm) shows the soil type: Phaeozems. Low and very low supply in mobile P shows the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols, with values between 8.2 and 17.9 ppm.The total area occupied by soils with a low content in mobile phosphorus is 11.648.1 ha. In Table 15, the state of phosphorus supply of the soils of the Veljurilor Plain is presented.

Soils with low and medium potassium content

In order to assess the state of potassium supply of the soils of the Veljurilor Plain, analyzes were carried out regarding the mobile potassium content of the soils. Values ranging from 30 to 210 ppm were obtained. Good supply in potassium shows the type of soil: Phaeozems, showing supply values between 140 and 210 ppm.

Table 15

Phosphorus supply status of the soils of the Veljurilor Plain

Soil type	Distribution area	Area - ha	P – ppm Medium values	Reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	15,7 – 17,4	low
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	38,3 – 74,2	Medium-high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	8,6 – 17,3	low
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	8,2 – 15,6	low
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	8,4 – 17,7	low
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	8,2 – 17,9	low

Poor and medium supply in potassium shows the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols & Vertic Luvisols, Gleysols 30 – 120 ppm.The total area occupied by soils with a low content in mobile potassium is 4.278.1 ha. The soil potassium supply status of the soils of the Veljurilor Plain is presented in Table 16.

Table 16

Soil potassium supply status of the Veljurilor Plain soils

Soil type	Distribution area	Area - ha	K – ppm Medium values	reserve
Fluvisols	Inand, Bicaci, Gepiu, Gurbediu	469,7	70 - 120	Medium
Phaeozems	Toboliu, Cheresig, Livada, Roit, Sânnicolau Român, Berechiu, Gepiu, Cefa, Inand, Homorog	2067,8	140 - 210	Medium - high
Eutric Cambisols	Gepiu, Bicaci, Homorog, Ianoșda, Tulca, Căușad, Gurbediu	2448,6	90 - 120	Medium
Haplic Luvisols	Inand, Bicaci, Tulca, Gurbediu	3296,4	70 - 110	Medium
Stagnic Luvisols & Vertic Luvisols	Gepiu, Bicaci, Ianoșda, Homorog, Tulca, Căușad, Tinca, Sânnicolau Român	3808,4	30 - 65	low
Gleysols	Toboliu, Cheresig, Cefa, Inand, Ianoșda, Homorog	550,9	90 – 120	Medium

Ensuring optimal conditions for the growth, development and fruiting of crop plants depends on the reserve of soil nutrients (17). Through the administration of chemical and organic fertilizers, the fund of nutrients in forms accessible to plants is ensured, the mobility and electrokinetic potential of different ions in the soil solution and the absorbent complex are increased, the ratio between different ions in the solution is changed, the mobility of other elements in hard-to-reach forms from the soil reserve is ensured. The chemical analyzes carried out on the soils of Veljurilor highlighted low values of the supply of nutrients in the soil types: Fluvisols, Eutric Cambisols, Haplic Luvisols, Stagnic Luvisols, Vertic Luvisols, the total area being 10023 Ha. These soils react extremely favorably to the administration of mineral and organic fertilizers. Organic fertilizers are very effective, helping to improve the physical properties of the arable soil layer in addition to enriching the soil with nutrients. To restore assimilable nitrogen reserves, leguminous crops are indicated. On these soils, phosphorus fertilizers are poorly or moderately used, their effectiveness is increased by applying together with organic fertilizers. The use of chemical and organic fertilizers is the main means of increasing the fertility of these soils.

Recommended doses of chemical fertilizers are calculated in relation to the crop plant, specific consumption/ton of harvested product, expected production, the nutrient reserve of the soil [20].

CONCLUSIONS

The integrated research of local soil conditions, with climatic conditions and the requirements of agricultural crops in relation to vegetation factors, is part of the concept of practicing sustainable agriculture (29, 30). Carrying out research in which the limiting and restrictive factors of agricultural production are defined, cataloged and studied and the establishment of the main directions of intervention to ensure optimal conditions in relation to the requirements of agricultural crops constitute the basis of a sustainable agriculture. This research can be the basis for realizing programs to restore the fertility potential of soils in areas where intensive agriculture is practiced (16). The research carried out in the Veljurilor Plain can be stored in databases and used later by the units with an agricultural profile, for: choosing the assortment of agricultural crops with a high degree of adaptability to local soil and climate conditions; the introduction into agricultural practice of drought-resistant species, varieties and hybrids; carrying out cartograms with soil properties, technological indicators and production capacity; the correct application in units with an agricultural profile of a differentiated agricultural technique by correlating the physico-chemical properties of the soil with the requirements of the crop plants; the design of land improvement works and works to restore the soil's fertility potential; the design and establishment of irrigation systems considering the fluctuations of the pluviometric regime; the organization of the territory. The research can be integrated into the National Soil Quality Monitoring System, an integral part of the International Environmental Quality Monitoring System.

REFERENCES

1. Seppelt, R.; Koltz, S.; Peiter, E.; Volk, M. Agriculture and food security under a changing climate: An underestimated challenge. Iscience. 2022, 25, 1- 13. https://doi.org/10.1016/j.isci.2022.105551
2. Hatfield, J. L.; Boote, K. J., Kimball, B. A.; Ziska, L. H.; Izaurralde, R. C.; Ort, D.; & Wolfe, D. Climate impacts on agriculture: implications for crop production. Agronomy journal 2011, 103(2), 351-370. https://doi.org/10.2134/agronj2010.0303
3. National Meteorological Administration. A Guide to Adapting to the Effects of Climate Change. Available online: https://nap.nationalacademies.org/catalog/12783/adapting-to-the-impacts-of-climate-change
4. The natural setting of the Crişurilor Plain and the Crisene Hills. https://www.scrigroup.com/geografie/Cadrul-natural-al-Campiei-Cris33485.php
5. Huismans, R. S; Bertotti, G.; Ciulavu, D.; Sanders, C. A. E., Cloetingh, S. A. P. L.; Dinu, C. Structural evolution of the Transylvanian Basin (Romania): a sedimentary basin in the bend zone of the Carpathians. Tectonophysics. 1997, 272, 249-268. https://doi.org/10.1016/S0040-1951(96)00261-2
6. Map of relief units in Romania. Available online: https://www.geotutorials.ro/atlas-geografic/harti-romania/
7. Posea, G. Geografia fizică a României. https://www.academia.edu/6964997/Geografia_Fizica_a_Romaniei_Partea_2
8. Standards and Methodologies regarding Natural Resources and the Environment. Available online: https://icpa.ro/standarde/
9. Ispas, St.; Murătoreanu, G.; Leotescu, R.; Ciulei, S. Pedology, soil research in the field. Valahia University Press, Târgovişte, 2006. Available online:

https://scholar.google.ro/citations?user=fZYH0PYAAAAJ&hl=ro
10. The Romanian Soil Taxonomy System. Available online: https://ro.scribd.com/document/374689589/Sistemul-Roman-de-Taxonomie-a-Solurilor-2012-SRTS
11. World reference base for soil resources. Available online: https://www.fao.org/3/w8594e/w8594e00.htm
12. Archive of the Oradea Meteorological Station.The National Meteorological Administration. Available online: https://www.meteoromania.ro/
13. Monitoring the state of soil quality in Romania. Available online: https://www.icpa.ro/proiecte/Proiecte%20nationale/monitoring/atlasICPA.pdf
14. Combating Desertification in the EU. Available online: https://op.europa.eu/webpub/eca/special-reports/desertification-33-2018/en/
15. Rust, N.; Lunder, O. E.; Iversen, S.; Vella, S.; Oughton, E. A.; Breland, T. A.; Reed, M. S.; Perceived Causes and Solutions to Soil Degradation in the UK and Norway. Land. 2022, 11(1), 131. https://www.mdpi.com/1450308
16. MichaelT. Löbmann, Linda Maring Gundula Prokop, Jos Brils, Johannes Bender, Antonio Bispo, Katharina Helming.Systems knowledge for sustainable soil and land management, https://doi.org/10.1016/j.scitotenv.2022.153389
17. Raza, A.; Razzaq, A.; Mehmood, S. S.; Zou, X.; Zhang, X.; Lv, Y.; Xu, J. Impact of climate change on crops adaptation and strategies to tackle its outcome: A review. Plants 2019, 8(2), 34. https://doi.org/10.3390/plants8020034
18. Guide on the conservation and rational use of soil moisture. Available online: https://www.gwp.org/globalassets/global/gwp-cee_files/regional/idmp-guide-moldova-ro.pdf
19. Guide for the preparation of Drought Management Plans. Available online: https://climate-adapt.eea.europa.eu/en/metadata/guidances/guidelines-for-preparation-of-the-drought-management-plans
20. Berchez O.; Stanciu A.; Research on soil degradation in the Crişurilor plain, Research Article, International Journal of Multidisciplinary Research Updates 2021, 01(01), 026–036. https://doi.org/10.53430/ijmru.2021.1.1.0033
21. Sopotlieva D.; Apostolova I.; Dry Grassland Vegetation in the Transition Zone Between Two Biogeographic Regions. https://doi.org/10.2478/hacq-2014-0010

22. Drought monitoring in Romania. Available online: https://edo.jrc.ec.europa.eu/edora/docs/EDORA_2022061617/Alexandru_JRC_17june2022-Daniel-AGRORomania.pdf
23. Rusu Teodor, Horea Cacovean, Paula Moraru , Ileana Bogdan, Mara Sopterean, Doru Marin, Adrian Pop, Camelia coste, Rafael Marian, Soil Moisture and Temperature Regimes Monitoring in the Transylvanian Plain, Romania, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9883/8234
24. Dubiac Daniela, Variation of Crop Yield in Agrocoenoses under Influence of Climatic Factors, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9892
25. Sălăgean Tudor, Dardja Marcel, Hoble Adela, Studies upon Climatic Soil Moisture Indicators, Available online: https://journals.usamvcluj.ro/index.php/promediu/article/view/9934
26. Weidorf David, Haggard Beatrix, Rusu Teodor, Soil Temperatures of the Transylvanian Plain, Romania. Available online: http://dx.doi.org/10.15835/buasvmcn-agr:3979
27. Rusu Teodor, Weindorf David, Haggard Beatrix, Moraru Paula Ioana, Cacovean Horea, Ileana Bogdan, and Mara Lucia Sopterean, Soil Moisture and Temperature Monitoring for Sustainable Land and Water Management in Transylvanian Plain, Romania. Available online: https://meetingorganizer.copernicus.org/EGU2011/EGU2011-2690.pdf
28. Rusu Teodor, Moraru Paula, Coste Camelia, Cacovean Horea, Chetan Felicia, Chetan Cornel, Impact of climate change on climatic indicators in Transylvanian Plain, Romania. Available online: https://www.academia.edu/20196767/Impact_of_climate_change_on_climatic_indicators_in_Transylvanian_Plain_Romania
29. Rusu Teodor, Moraru Ioana Paula, Sopterean Maria Lucia, Climate Monitoring and Recommendations on the Optimum Sowing Period for the Main Crops in the Transylvanian Plain, Romania, Available online: https://www.researchgate.net/publication/258614910_Climate_Monitoring_and_Recommendations_on_the_Optimum_Sowing_Period_for_the_Main_Crops_in_the_Transylvanian_Plain_Romania
30. Rusu Teodor, Climate Monitoring and Water Resources Management for the Main Crops in the Transylvanian Plain, Romania. Available online:

https://www.academia.edu/64426320/Climate_Monitoring_and_Water_Resources_Management_for_the_Main_Crops_in_the_Transylvanian_Plain_Romania

31. Rusu Teodor, Weindorf David, Haggard Beatrix, Cacovean Horea , Moraru Paula Ioana, Pop Adrian, Pop Lavinia, and Sopterean Maria Lucia. Soil Temperatures, Water and Humus Conservation of the Transylvanian Plain, Romania. Available online: https://meetingorganizer.copernicus.org/EGU2010/EGU2010-1092-1.pdf
32. Haggard Beatrix, Rusu Teodor, Weindorf David, Sopterean Mara, Spatial Soil Temperature and Moisture Monitoring Across the Transylvanian Plain in Romania, https://www.researchgate.net/publication/357317069_Spatial_Soil_Temperature_and_Moisture_Monitoring_Across_the_Transylvanian_Plain_in_Romania
33. Rusu Teodor, Moraru Paula Ioana. Impact of climate change on crop land and technological recommendations for the main crops in Transylvanian plain, Romania. Available online: https://www.researchgate.net/publication/282053072_Impact_of_climate_change_on_crop_land_and_technological_recommendations_for_the_main_crops_in_Transylvanian_plain_Romania?_

STUDY OF A SILVOPASTORAL SYSTEM WITH TURKEY OAK (*QUERCUS CERRIS* L.) IN DOBROGEA

Elena TAULESCU[*], MARUȘCA Teodor [**], MEMEDEMIN Daniyar[,****], ȚÎBÎRNAC Marcel[**], MIHĂILĂ Elena[***]**

[*] *Faculty of Silviculture and Forest Engineering, Transilvania University of Brasov*
[**] *Research-Development Institute for Grasslands Brasov*
[***] *National Institute for Research and Development in Forestry "Marin Drăcea", Bucharest*
[****] *Faculty of Natural and Agricultural Sciences ,Ovidius University of Constanța*
[*****]*Collaborator e-mail address: taulescuelena@yahoo.com*

Abstract

Changing climate and global warming are a major challenge for livestock farming especially during the grazing season. Silvopastoral systems are a viable solution to mitigate the negative effects of drought on the grassland and livestock. The research was carried out in Visterna, Dobrogea province, on existing grasslands under a 35-40 year old Turkey oak plantation, with an average density of 867 trees per hectare. The green mass production was evaluated at 3.4 t/ha, which can ensure an optimal load of 0.4 LU/ha in 130 days of grazing season. The calculated pastoral value is 16.3 and the estimated milk production can reach 1,300 liters/ha. This system with grass and planted trees can be a solution for the seasonal conditions with moisture deficit and higher temperatures from the future.

Keywords: silvopastoral system, *Quercus cerris* plantation, tree features, grassland productivity.

INTRODUCTION

Agroforestry is a different way of using land compared to agriculture, forestry or animal husbandry taken singly, which combines either trees with cultivated plants, trees with livestock or trees, cultivated plants and livestock. (MCADAM et al. 2009, MIHĂILĂ et al. 2010, MOSQUERA-LOSADA et al. 2012).

The objective of agroforestry is to reduce the possibility of certain natural risks such as desertification, land degradation, etc. and to create the highest possible yields for farmers. The presence of trees in the agricultural land increases land productivity, offering multiple ecological, economic and social services at local and regional levels, ensuring through wood production a constant additional income for land owners who use agroforestry systems, increasing thus their financial stability (RIGUEIRO-RODRÍGUEZ et al. 2009).

The way in which the components of agroforestry systems (trees/shrubs, crops, animals) are arranged in space and time, making the differece between these activities, is done in accordance with the role of the trees and the functions they perform. Intercroppings, perimetral tree fences, windbreak forest belts, planting of forest shrub species for soil conservation, clump of trees on agricultural land, etc. are agroforestry practices within these systems. Any of these practices turn into a functional system when it reaches a certain stage of development for a specific area, representing the usual way of using the land in the region. (MIHĂILĂ *et al.* 2010).

The silvopastoral system with *Quercus cerris* (SsQc) represents a category of agroforestry system with a long tradition, especially in the arid and semi-arid areas of our country..

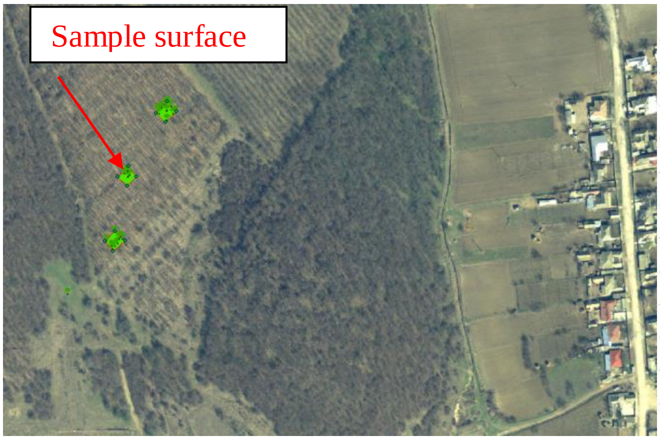
MATERIAL AND METHOD

To study the influence of trees on the vegetation layer and directly or indirectly on grazing livestock in a silvopastoral system, we made measurements of forest and herbaceous vegetation, analyzed the agrochemical characteristics of the soil and studied the relationships that exist between the component elements of the system.

The research werecarried out in Visterna village, Sarighioi commune, Tulcea county (Fig. 1), in a Turkish oak plantation (*Quercus cerris*, L.), grazed during the summer with sheep and goats, the main role of the trees within this silvopastoral system being to provide shade for the livestock.

Fig. 1 Geographical position and location of Visterna on the map of Tulcea county (https://ro.wikipedia.org/wiki/Visterna,_Tulcea)

The fieldwork consisted of delimiting the research perimeter into 3 sample areas of 100 sq m each (Fig. 2), areas on which floristic surveys were carried out, soil samples were taken at a depth of 0 - 10 cm with an agrochemical sampler and biometric measurements of the trees were made, for each specimen being assigned a number. The trunk diameter was measured with a tree caliper at a height of 1.30 m and the tree height up to the terminal bud was measured with a dendrometer (Fig. 3,4).



Pct.	X (EST)	Y (NORD)
1	797551.062	381068.066
2	797542.957	381060.040
3	797549.544	381052.083
4	797558.856	381060.447
5	797560.646	381103.986
6	797552.968	381110.980
7	797561.857	381119.436
8	797567.990	381111.237
9	797591.018	381154.355
10	797583.305	381161.458
11	797592.266	381170.942
12	797599.760	381163.160

Fig. 2 Location of sample surfaces and inventory of Stereo 70 coordinates for the corners of each analyzed plot

Fig. 3 *Fig. 4*

Silvopastoral system with Quercus cerris

Soil analyses were carried out by the Brașov Pedological and Agrochemical Studies Office. The determinations regarding the productivity of the vegetation layer (qualitative and quantitative) from the silvopastoral system with Turkey oak, were made using the method proposed by Marușca in 2019. In this regard, floristic surveys were carried out assessing directly the percentage participation of species (P %) in the vegetal layer in order to be able to further perform calculations regarding the pastoral value (PV), the production index (IP) and the net production of green fodder (GF t/ha). To evaluate the results, data from the specialized literature on the agrochemical characteristics of the soil, the silvopastoral management guidelines, the forestry code and the technical norms for forest management were used.

RESULTS AND DISCUSSIONS

The degree of soil supply with nutrients directly influences the floristic composition of the studied system. The results of the analyzed soil samples highlight the trophicity of the silvopastoral system with Turkey oak compared to the optimum in the specialized literature (Table 1).

Table 1

Agrochemical values of open field and shaded meadow soil

Specification	Unit	*Optimal values	SsQc	Diff. 2-1 (+, -)	%
pH in H_2O	ind.	6,60	7,00	+0,40	106
Soil humus	%	6,16	5,00	-1,16	81
Nitrogen Index	%	5,79	0,20	-5,59	3
Mobile Phosphorus	ppm	6,00	108	+102	18
Mobile Potassium	ppm	230	265	+35	115
Base saturation (BS)	%	94	60,00	-34	64

* according to the methodology of the National Research and Development Institute for Pedology and Agrochemistry 1981 and 1987.

The supply of soil nutrients (nitrogen, phosphorus, potassium) from the silvopastoral system with Turkey oak, necessary for the development of forage plants, does not register optimal values for obtaining a vegetal layer with high pastoral value. The presence of trees on grasslands, whether planted or from natural regeneration, produces changes in the floristic composition of the vegetal layer, in the structure and spatial distribution of herbaceous plant communities, leading to the birth of micro-ecosystems with different species that are not found on grasslands without trees (LÓPEZ-SÁNCHEZ *et al.* 2016). The dominance of the species *Bromus* sp. (table 2), whose forage quality indicator and useful forage phytomass indicator is low (value 5-6 according to Marușca, 2019), reflects the soil's poverty in nutrients.

Table 2

Floristic composition and productivity of grasslands in the silvopastoral system with Turkey oak from Visterna

Nr.sp.	Species	Survey no.			Average
		1	2	3	%
	Acoperire vegetație(%)	100	100	100	100
	Species from Poaceae family				
1	*Bromus arvensis*	40.0	45.0	15.0	33.3
2	*Bromus sterilis*	24.0	25.0	65.0	38.0
3	*Brachypodium sylvaticum*	5.0	10.0	5.0	6.7
4	*Dactylis glomerata*	3.0	2.0	1.0	2.0
5	*Festuca valesiaca*	1.0	7.0	1.0	3.0
6	*Poa angustifolia*		1.0	5.0	2.0
7	*Melica ciliata*		1.0		0.3
8	*Triticum aestivum*		1.0		0.3
	Other plant families				
9	*Quercus cerris*	80.0	70.0	90.0	80.0
10	*Carpinus orientalis*	2.0	5.0	0.1	2.4
11	*Teucrium chamaedrys*	2.0	2.0	0.1	1.4
12	*Agrimonia eupatoria*	1.0	1.0	1.0	1.0
13	*Torilis arvensis*	1.0	0.1	0.1	0.4
14	*Fragaria vesca*	1.0	3.0	2.0	2.0
15	*Ballota nigra*	1.0			0.3
16	*Cynanchum acutum*	0.1	0.1	1.0	0.4
17	*Marrubium vulgare*	0.1	1.0		0.4
18	*Cirsium vulgare*	0.1			0.1
19	*Rosa canina*	0.1	0.1		0.1
20	*Allium flavum*	0.1	0.1	0.1	0.1
21	*Chenopodium album*	0.1			0.1
22	*Achillea setacea*	0.1	1.0		0.4
23	*Potentilla reptans*	0.1	0.1		0.1
24	*Crataegus monogyna*		5.0	0.1	1.7
25	*Lepidium draba*		1.0		0.3
26	*Muscari racemosum*		0.1	0.1	0.1
27	*Viola odorata*		0.1	0.1	0.1
28	*Silene vulgaris*		0.1		0.1
29	*Caucalis platycarpos*		0.1		0.1
30	*Geum urbanum*		0.1		0.1
31	*Pirus piraster*		0.1		0.1
32	*Ligustrum vulgare*		0.1		0.1
33	*Fraxinus ornus*		0.1	0.1	0.1
34	*Ulmus campestris*		0.1		0.1
35	*Potentilla argentea*		0.1		0.1
36	*Myrrhoides nodosa*			1.0	0.1
37	*Buglossoides purpurocaerulea*			0.1	0.1

Applying the method proposed by Marușca in 2019 to determine the productivity of the vegetation cover in the silvopastoral system with Turkey oak, the following results were obtained:
-Number of species 37
-Fodder plant species: 28%
-Harmful plant species: 72%
-Green fodder production: 3,4t/ha
-Optimal loading with livestock: 0,40 LU/ha
-Optimal grazing period: 130 zile
-Pastoral value: 16,3 (weak)
-Milk production: 1300 liters/ha.

At an optimal density of trees on the grassland, their shade and the moisture they can retain in the soil due to their root system and wide canopy are very important aspects for the development of a diverse, rich vegetation cover and also beneficial for obtaining very good quality fodder (LÓPEZ-CARRASCO *et al.* 2015, LÓPEZ-SÁNCHEZ *et al.* 2016).

Upon inventorying all the trees in the three experimental plots of silvopastoral system with Turkey oak under study, a total number of 26 trees with an average diameter of approximately 20 cm and an average height of 10 m resulted (Table 3).

Table 3

General information of (*Quercus cerris)* trees inventoried in the silvopastoral system

Quercus cerris	Nr. of individuals	Min.	Max.	Av.	Standard error	Variant	Standard deviation	Coefficient of variation
Diameter	26	6,37	25,73	18,88	0,89	20,93	4,58	24,24
Height	26	5,00	12,10	10,36	0,29	2,22	1,49	14,38

Graphical distribution for diameter and height of inventoried specimens

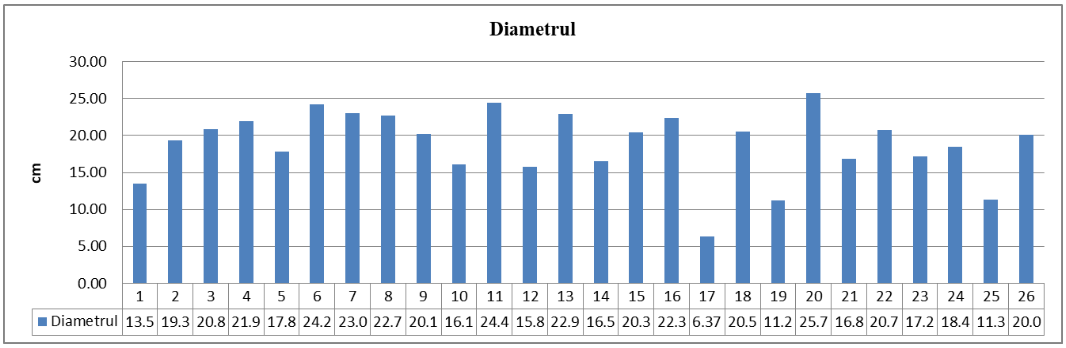


Fig. 5 Graphic representation of the diameters of each specimen

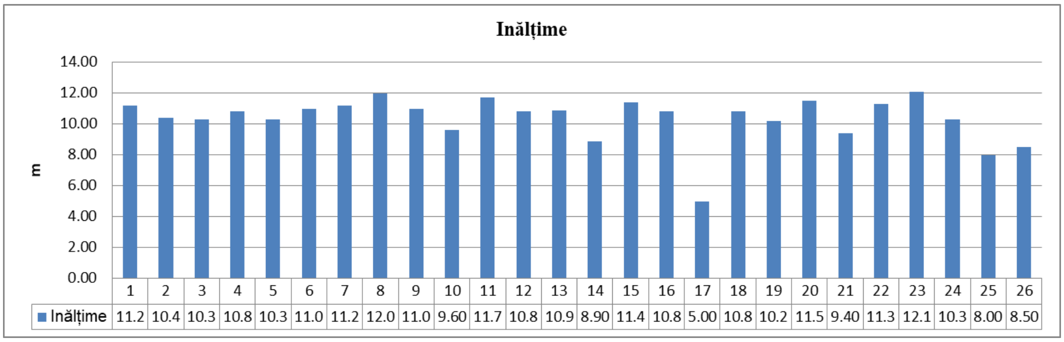


Fig. 6 Graphical representation of the heights of each specimen

According to the Technical Norms for Forest Management (2022), the average age of the spruce plantation that forms the silvopastoral system under study is 35-40 years.

The calculations resulted in a density of 867 trees/ha and therefore a coverage of 80% of the system surface. The canopy density provided by the foliage effectively distributes light and heat at ground level, not being identifyed surfaces devoid of herbaceous vegetation in the studied area. However, it is known that inour country, areas of regenerated pastures or planted with trees with a consistency equal to or greater than 0.4 are included in the forestry systems, grazing being prohibited in them. The exception is these areas, bordering the compact forest, which in the past were part of the agricultural field but wich, due to the need to restore some ecosystems or to stabilize soils , were replanted. These plantations in the Dobrogea area, due to long periods of drought, lack of water and dryness, are frequently exploited by livestock farms in their vicinity.

Trees and also the loading with grazing livestock are very important factors in maintaining grassland diversity. Exceeding the optimum number of grazing cattle and/or sheep can lead to the emergence of plant associations dominated by nitrophilic species (MORENO *et al*. 2016), which is undesirable for obtaining high-quality forage.

The field assessment showed that the phytosanitary condition of the trees in the studied silvopastoral system with Turkey oak is generally good, with specific forestry works observed across the entire area.

For the sustainability of silvopastoral systems, it is necessary to respect all the technical solutions provided by silvopastoral or forestry systems, especially by performing maintenance works on time, and grazing being carried out in accordance with the optimal support capacity of the system.

Under the conditions of rational management of the silvopastoral system with Quercus cerris from Visterna (and beyond), less labor could be used and less money invested for both wood and livestock production than in the case of each crop separately.

CONCLUSIONS

Silvopastoral systems are a viable solution in the context of global climate change.

The biometric characteristics of *Quercus cerris* trees, aged 35-40 years, are an average height of 10 m and an average diameter of 20 cm, not very wide canopy, but which, at a density of 867 specimens per hectare, cover the ground with shade in a proportion of 80%.

The productivity of the grassland under *Quercus cerris* trees is lower, namely 3.4 t/ha green fodder and 16.3 pastoral value, ensuring 1,300 liters of milk per hectare in 130 days of grazing season, with an optimal load of 0.4 LU/ha.

Although the results obtained regarding the forage productivity of the silvopastoral system with Turkish oak from Visterna are not spectacular compared to the dry grasslands without forest vegetation in Dobrogea, the research recommends capitalizing on forested or planted pastures bordering the compact forests and promoting these exploitation systems as a priority in the context of the constant increase in temperatures and the danger of aridization in the future.

REFERENCES

1. Anonymous, 2008, consolidate 2024. Law 46/Forestry Code (In romanian)
2. Kovacs A. J. (1979). Biological, ecological and economic indicators of meadow flora, Agricultural Technical Propaganda Editorial Office, Bucharest, 50 p. (In romanian).
3. Marușca, T. (2019). Contributions to the evaluation of pasture productivity using the floristic releve. Romanian Journal of grassland and forage crops, 19, 33-47.
4. Mihăilă E, Costăchescu C, Dănescu F, Drăgoi S (2010). Agroforestry systems. Editura Silvică, București. (In romanian)
5. McAdam, J. H., Burgess, P. J., Graves, A. R., Rigueiro-Rodríguez, A., & Mosquera-Losada, M. R. (2009). Classifications and functions of agroforestry systems in Europe. Agroforestry in Europe: current status and future prospects, 21-41.
6. Mosquera-Losada, M. R., Moreno, G., Pardini, A., McAdam, J. H., Papanastasis, V., Burgess, P. J., ... & Rigueiro-Rodríguez, A.

(2012). Past, present and future of agroforestry systems in Europe. Agroforestry-The future of global land use, 285-312.
7. López-Carrasco C., López-Sánchez A., San Miguel A., Roig S. (2015). The effect of tree cover on the biomass and diversity of the herbaceous layer in a Mediterranean dehesa. Grass and Forage Science, 70(4), 639-650.
8. López-Sánchez A., San Miguel A., López-Carrasco C., Huntsinger L., Roig S. (2016). The important role of scattered trees on the herbaceous diversity of a grazed Mediterranean dehesa. Acta Oecologica, 76, 31-38.
9. Rigueiro-Rodríguez, A., Fernández-Núñez, E., González-Hernández, P., McAdam, J.H., Mosquera-Losada, M.R. (2009). Agroforestry Systems in Europe: Productive, Ecological and Social Perspectives. In: Rigueiro-Rodróguez, A., McAdam, J., Mosquera-Losada, M.R. (eds) Agroforestry in Europe. Advances in Agroforestry, vol 6. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-8272-6_3
10. *** Technical norms for forest management approved with OM 2536/2022. (In romanian)
11. ***Software Past 4.02. (https://softfamous.com/past/).
12. ***Software ArcGis 10.3.
13. ***Google Earth Pro, 2019.
(https://ro.wikipedia.org/wiki/Visterna,_Tulcea)
14. ***Methodology of the National Research and Development Institute for Pedology and Agrochemistry 1981 and 1987.

THE ROMANIAN SOCIETY FOR GRASSLANDS

The Bureau of the Romanian Society for Grasslands

President: Costel SAMUIL
Vice - President: Florin Simion PĂCURAR
Vice - President: Veronica SĂRĂȚEANU
General Secretary: Adrian Vasile BLAJ
Member - Teodor MARUŞCA
Member – Aliona MIRON
Member - Ioan ROTAR
Member - Vasile VÎNTU
Censor: Gabriela IGNAT

Committee of Founding Members of the Romanian Society for Grasslands

Neculai DRAGOMIR
Teodor MARUŞCA
Alexandru Pavel MOISUC
Iosif RAZEC
Ioan ROTAR
Costel SAMUIL
Mirela-Roxana VIDICAN
Vasile VÎNTU

Adhesion to The Romanian Society for Grasslands

Contact Address of the Romanian Society for Grasslands:
CLUJ-NAPOCA, MĂNĂŞTUR Street, No. 3 - 5, Room no: 46, 400372, District CLUJ, e-mail: sropaj@yahoo.com
www.sropaj.ro

RJGFC

The Romanian Society for Grassland

Contact Adress:

Mănăştur Street, No. 3 - 5,
Chamber 46, Postal cod 400372
CLUJ-NAPOCA, ROMANIA

e-mail: sropaj@yahoo.com
https://sropaj.ro

ISSN 2068-3065