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Grassland association stock of plants the examination of the regeneration of a construction

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SUMMARY

Due to the drastic change in using the nature like grassland association (one-sided overgrazing – one mowing per a year), by the third year of the experiment in every area, where overgrazing stopped, independently on second sowing and nutrient resupply, Borhidi degradation degree decreased. In the areas where overgrazing with large animal density (sheep) continued, degradation degree was 3.4–5.0 by the third year of the experiment, and Hordeum murinum, which causes animal healthy problems, appeared massively.

Keywords: *overgrazing; degradation; recultivation*

INTRODUCTION

In Hungary, grassland cultivation occupies 11% (799.3 thousand hectars) of the agriculture and nowadays it is also a significant potential fodder base. However, the actual situation is more complex. Firstly, the proportion of unutilised areas is significant, according to the data approximately 20% is all over the country. Secondly, there is overutilisation which is caused by inefficient grazing. In our study, we write about this latter grassland degradation danger.

Overgrazing is one of the most ancient problems for shepherds, as it caused migration, destroying wars for over time. Also nowadays it is a chronic problem nationwide. Overgrazing causes problems all over the world, such as in Europe (Gill, 1990), in Africa (Mace, 1991), in the USA (Herbel, 1979; McNaughton, 1979), in Australia and in New-Zealand (Coomes et al., 2003). The grazing animals affect the competition among plants because of their nutrition and treading (Canals & Sebastia, 2000). If the density of animals is not perfect, later it can also change the composition of the vegetation (Montalvo et al., 1993; Milchunas et al., 1998). According at Bullock et al. (1994) overgrazing causes bare areas, which can be microhabitat, where the seeds of the plants can germinate, so they induce the form of random mosaic structure. Altogether, overgrazing causes decreasing of the favoured herbaceous plants (Grime, 1973; Hobbs & Huenneke, 1992), which causes soil erosion and decreases biodiversity (Courtois et al. 2004; Evans, 2005; Thornes, 2007; Schoenbach et al., 2011). The useful proportion of the grassland is continuously decreasing. The larger bare areas form on the places which the animals like such as resting places and drinking trough (Evans, 1977; Mackay & Tallis, 1996). Huber et al. (1995) warned of the rise of local degradation on the fields. In the surrounding of the barns we cannot avoid over-treading. This kind of grazing rises the size of overgrazed area, while the other parts of the field remain without grazing. The culmination places are around the barn, causing the soil to become bare. Grazing affects not only the plants but the soil. Overgrazing with treading decreases porosity, the effectiveness of participation infiltration, so moisture loss (Fanning, 1994; Erickson, 2005) and nutrition lack (Zhao et al., 2007) can appear. Climo & Richardson (1984) concluded that in rainy period the repeating treading can cause the loss of original soil structure near the surface. Molinillo (1993) saw the intensive erosion of the investigated regions in Andok because of the large number of animals. According to Lasanta et al. (2001) the overgrazing is responsible for the severe soil erosion on the Rioja part of the Iberian mountains. From the east of us 16 million small ruminants are kept in Romania. The grassland of 90% is overgrazed there. Nowadays, one of the miracle of the flora in the Carpathian Basin, the continuous large narcissus field (~40 ha) is only found on Mócföld in the hidden Negrileas valley surrounded with sheepfold full of animals.

In Hungary, it can be stated that, until 20th century, farmers saw their property only in the livestock, they did everything for having as many animals as possible like our relatives also do in Middle-Asia nowadays. Everything had fodder value: grass in ditches, all agriculture byproduct, young plants in forests and reeds. The naked fields were relevant examples of this era. From the 1980s approach change was happening. Barns and fields were empty, elimination of collective farms removed grazing livestock. The shepherds were forced back to the national parks. Mechanized agriculture was gradually spreading. We mention an example for declining of sheep breeding. In Karcag (1868) the lack of sheep was first announced. 83 000 adult sheep were found by the soldiers. At the time of regime change 34 000 sheep were grazing (this is the heraldic animal of the city). 6000 hectars from 43 000 hectars of the periphery of the city are grassland, but the number of sheep population does not reach 3000. Some famers try to keep cows, but approximately one third of the grassland in the city is on lea-land. Nowadays, underutilisation is a bigger problem on the grassland (Erdős et al., 2013; 2014; Bajor et al., 2016), but there are also naked grasslands. Overgrazing is caused by winter grazing because of fodder lack, whose harmful effects was written by Princz (2017). The special role of grazing for naked area, the targeted

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overgrazing, where the aim is to remove the overgrown, perennial plants, weeds germinating from their seeds, the animals return to the total regeneration. There will be another steady problem, i.e. the grazing gardens next to animal ranches will become more and more naked because of becoming overburdened. Due to the lack of qualified employee, farmers replaced the shepherds with technology. The aim is to provide a grazing garden for all the animals not only youngsters in order not to need shepherds. There would be rules for example grazing garden can only be created on species-poor grassland with lea-land origin, the utilisation methods should be changed, at times mowing is needed. The most balanced flora and weeding-free area can be reached by changing grazing and mowing methods. Only grazing the pungent, poisonous weeds while by only mowing potential weeds spread. Regeneration time should be provided to the grassland. But in the practise day by day the animals are on same area because of the lack of shepherds and their convenience, while further fields become heathery. Without regeneration time the grassland becomes thinner and the weeds, which the animals do not favour, appear (Szente et al., 1998; Czóbel et al., 2012).

On our nature-like grasslands, in order to maintain biodiversity and culture condition an utilisation must be done which leads to the typical state (Török et al., 2014; Valkó et al., 2017). For both the economical and conservationist viewpoint, professional maintenance is more efficient than reconstructing the run-down grasslands (Török et al., 2012; Valkó et al., 2016).

The most effective utilisation method of our salty steppes is extensive grazing, the collected grazing with shepherds. Although there is renaissance of shepherd traditions, nowadays this is mostly folklore and not the resistance next to the animals on 365 days of the year. In the profit-oriented animal husbandry a solution had to be found to replace the good shepherds. The solution: grazing gardens must be built, where the animals can freely graze. In addition, the grazing gardens must be created next to the animal ranches because of convenience. Grazing gardens with fixed fence are spreading, where because of day by day grazing the grassland will become species-poor and endoparasites appear and reproduce.

The aim of our study is the identification of the direction and the measure of degradation in the flora of a sheepgrazing garden which was excluded from grazing because of overburden in order to recultivation.

MATERIALS AND METHODS

Our experiment was carried out between 2017–2020 on the grassland number 01712/1 of the Research Institute of Karcag, Hungarian University of Agriculture and Life Sciences. In spring 2017 sheep were excluded from the area which in the former three years was overgrazed (25 sheep ha^{-1}). We indicated nine treatments in three repetitions, the size of the parcels is 4×5 m (20 m^2) with 0.5 m roads. Sign F is sowing with *Lolium perenne* (0, 20, 40 kg ha^{-1}), sign K is sheep dung based Terrasol biocompost (license number: 02.5/48/7/2008) (0, 20, 40 t ha^{-1} portions). Sign TL/1-3 means the overgrazed parcels (25 sheep ha^{-1}).

At the beginning of the experiment, soil samples were taken from 0–10 cm deep and the results are in the following table (*Table 1*):

Table 1. **Results of general soil sampling (Karcag, 2017)**

pH-value	**Soil plasticity of Arany**	**Humus**	**NO_3-N**	**P_2O_5**	**K_2O**
KCl		**m/m%**	**mg kg^{-1}**	**mg kg^{-1}**	**mg kg^{-1}**
5.10	43.00	3.80	3.00	46.00	253.00

The areas belong to Pannonia flora, the trans-Tisza region of the flora area of the Great Hungarian Plain (Hortobágyi & Simon, 2000). The experiment was in the *Achilleo-Festuceteum pseudovinae* and the *Artemisio santonici-Festucetum pseudovinae* transitional grassland association.

The experimental site was situated at an elevation of 83 meters above sea level, and the mean annual precipitation over a span of 50 years amounted to 503.4 millimeters. Annual precipitation and temperature data for the study period are presented in the following table (*Table 2*).

Table 2. **Weather data for the study period (Karcag, 2017–2020)**

Year	**Annual average temperature (°C)**	**Annual precipitation (mm)**
2017	11.20	527.50
2018	12.50	557.80
2019	13.30	505.10
2020	11.70	648.50

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Monitoring the grassland association in each year of the experiment was done with Balázs quadrate method in the time of blooming of dominant gramma species (Balázs, 1949), where on the studied quadrate the size of the area used by plant species is determined with dominance value by Balázs (DB) (1):

$$\text{Cover\%} = \frac{\text{DB}\times 100}{\text{DBmax}} \qquad (1)$$

The scientific names of plant species are classified according to Király (2009).

After coenological monitoring every plant species is classified into Social Behaviour Types (SBT) by Borhidi (1993) based on their ecological condition: SBT) between 2017–2020. The degradation degree (Dʄ) is determined with SBT based on Borhidi, the rate of degradable species and natural species are considered. The natural species are specialists (S), competitors (C), generalists (G), natural pioneers (NP), degradable species are disturbance tolerant species (DT), natural weeds (W), established strange species (I), arrival species (A), ruderal competitors (RC) and aggressive land-strange invasive species (AC). The bare area is not considered. Degradation degree by Borhidi (1993) was calculated according to the following formula (2):

$$\text{D}ʄ = \frac{\Sigma\text{DT} + \Sigma\text{W} + \Sigma\text{I} + \Sigma\text{A} + \Sigma\text{RC} + \Sigma\text{AC}}{\Sigma\text{S} + \Sigma\text{C} + \Sigma\text{G} + \Sigma\text{NP}} \qquad (2)$$

The data were evaluated in the following way: the data recorded in the experiments were recorded and summarised, and the results were processed and evaluated using Microsoft® Office Excel. One-factor analysis of variance (ANOVA) was used to test the data. Analysis of variance is used to determine whether there is a significant difference between the means of two groups. It is important to note, however, that statistical analysis does not show where the difference between the means of the two groups lies. For the statistical evaluation, the elements of the analysis of variance ("SS" is the sum of the squares of the variance of the factors, "DF" is the degree of freedom, "MS" is the mean sum of squares, "F" is the calculated F-value, "p-value" is the probability associated with the calculated F-value, "F crit" is the critical F-value) were used with the p-value at a 5% significance level. After performing the analysis of variance, a Fisher's Least Significant Difference (LSD) post-hoc test was performed, also at 5% significance level, to see if two means are statistically different from each other using the following formula ("t" is the two-tailed Student's t-test distribution, "MSw" is the between-group mean sum of squares, "N" is the sample size) (3). If the difference between the means of the groups is greater than the calculated LSD test value, it is considered significant.

$$\text{LSD} = \text{t} \times \sqrt{\text{MSw} \times (\frac{1}{\text{N}} + \frac{1}{\text{N}})} \qquad (3)$$

RESULTS AND DISCUSSION

Plants were classified into Borhidi's Types of Social Behavior based on their ecological value (specialists, natural competitors, generalists, natural pioneers, disturbance tolerant species, natural weeds, invasive species, arrival species, ruderal competitors, and aggressive land-strange invasive species (*Table 3*). During recultivation the experimental parcels were re-sowing with *Lolium perenne* which was breeding in Karcag Research Institute (20 kg ha^{-1}, and 40 kg ha^{-1}), but on salty area *Lolium perenne* does not come in at all, which was proved with coenological monitoring by Balázs.

Table 3. **SBT classification of the recorded plants (Karcag, 2017–2020)**

Plant name	**Borhidi's SBT**	
	Sign	**Value**
Alopecurus pratensis	C	5
Elymus repens	RC	-2
Festuca pseudovina	C	5
Festuca rupicola	C	5
Poa angustifolia	G	4
Lotus corniculatus	DT	2
Trifolium angulatum	S	6
Achillea collina	DT	2
Capsella bursa-pastoris	W	1
Cardaria draba	W	1
Cerastium vulgare	DT	2
Convolvulus arvensis	RC	-2
Crepis setosa	W	1
Daucus carota	DT	2
Erodium cicutarium	W	1
Galium aparine	W	1
Gypsophila muralis	NP	3
Inula britannica	DT	2
Plantago lanceolata	DT	2
Podospermum canum	G	4
Portulaca oleracea	W	1
Potentilla argentea	DT	2
Rumex obtusifolius	DT	2
Silene alba	W	1
Sonchus arvensis	W	1
Taraxacum officinale	RC	-2
Tripleurospermum perforatum	W	1
Veronica persica	W	1
Artemisia absinthium	W	1
Bromus hordeaceus	DT	2
Carduus acanthoides	W	1
Carduus nutans	DT	2
Conium maculatum	RC	-2
Eryngium campestre	DT	2
Hordeum murinum	W	1
Prunus domestica subsp. syriaca	I	-1

The degree of degradation was calculated based on the cover of plants classified according to SBT (*Table 4*).

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Table 4. **Degree of degradation between 2017 and 2020 (Karcag)**

Treatment	2017	2018	2019	2020
F0K0/1	0.600	0.409	0.318	0.277
F0K0/2	0.524	0.265	0.185	0.185
F0K0/3	0.455	0.216	0.123	0.123
F0K20/1	0.730	0.292	0.208	0.208
F0K20/2	0.432	0.260	0.143	0.123
F0K20/3	0.641	0.280	0.164	0.164
F0K40/1	0.455	0.185	0.164	0.123
F0K40/2	0.422	0.240	0.164	0.143
F0K40/3	0.641	0.422	0.255	0.143
F20K0/1	0.561	0.333	0.231	0.231
F20K0/2	0.600	0.286	0.191	0.191
F20K0/3	0.778	0.289	0.123	0.123
F20K20/1	0.561	0.212	0.208	0.192
F20K20/2	1.000	0.362	0.348	0.333
F20K20/3	0.528	0.377	0.348	0.260
F20K40/1	0.537	0.333	0.154	0.127
F20K40/2	0.306	0.143	0.085	0.068
F20K40/3	0.488	0.255	0.185	0.143
F40K0/1	0.488	0.212	0.185	0.185
F40K0/2	0.488	0.333	0.292	0.231
F40K0/3	0.306	0.231	0.185	0.143
F40K20/1	0.280	0.255	0.231	0.208
F40K20/2	0.939	0.340	0.208	0.143
F40K20/3	0.641	0.370	0.348	0.280
F40K40/1	0.306	0.280	0.208	0.208
F40K40/2	0.600	0.208	0.164	0.164
F40K40/3	0.455	0.400	0.319	0.319
TL/1	0.939	1.545	3.000	3.429
TL/2	1.560	3.833	4.8000	5.000
TL/3	2.100	2.412	3.286	3.429

On the parcels given 0 t ha^{-1} compost between 2017–2020 the degradation decreased with average 63.41%, while on the parcels given 20 t ha^{-1} compost with average 57.344%, and on the parcels given 40 t ha^{-1} with average 58.392%. On the parcel with 0 t ha^{-1} treatment degradation degree was in 2017 0.306–0.778, in 2018 0.212–0.409, in 2019 0.123–0.318, and in 2020 0.123–0.277. On areas given 20 t ha^{-1} compost the degradation degree was in 2017 0.280–1.000, in 2018 0.212–0.377, in 2019 0.143–0.348 and in 2020 0.123–0.333. On the areas given 40 t ha^{-1} compost the degradation degree was in 2017 0.306–0.641, in 2018 0.143–0.422, in 2019 0.085–0.319, and in 2020 0.068–0.319. With variance analysis we proved how the degradation changed on the areas where grazing was exchanged by mowing in the experimental period. On the parcels given 0 t ha^{-1} compost p-value was 6.62E^{-10}, given 20 t ha^{-1} compost it was 1.24E^{-07}, and given 40 t ha^{-1} compost it was 7.02E^{-08} over the period under review (2017–2020). These statistic values show that our results are significant, so degradation really decreased on this area (*Table 5*). The degradation of plots receiving 0 t ha^{-1} compost significantly decreased between 2017 and 2019, the degradation of plots receiving 20 and 40 t ha^{-1} compost significantly decreased between 2017 and 2018, in the other cases no significant decrease was detected in the post-hoc test. On the overgrazing areas (TL) the degradation was gradually increasing, by 2020 it was 3.4–5.0. In these parcels degradation between 2017–2020 increased with 182.991%. In 2017 it was 0.939–2.100, in 2018 it was 1.545–3.833, in 2019 it was 3.000–4.800, and in 2020 it was 3.4–5.0. Variance analysis did show significant result (p-value: 0.004) over the period under review (2017–2020). Using the LSD post-hoc test, we found that there was increase in degradation between 2017–2020 in the still over-alloyed (TL) treatment, which showed no significant association (*Table 6*).

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Table 5. **Results of the single factor analysis of variance by treatment in the study period (Karcag, 2017–2020)**

Source of variation	SS	df	MS	F	p-value	F crit.
0 t ha^{-1}						
Source of variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit.*
Between groups	0.688598	3	0.229533	32.95368	6.62E-10	2.90112
Within groups	0.22289	32	0.006965			
Total	0.911488	35				
20 t ha^{-1}						
Source of variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit.*
Between groups	1.039799	3	0.3466	20.66647	1.24E-07	2.90112
Within groups	0.536676	32	0.016771			
Total	1.576475	35				
40 t ha^{-1}						
Source of variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit.*
Between groups	0.52083	3	0.17361	21.81671	7.02E-08	2.90112
Within groups	0.254645	32	0.007958			
Total	0.775475	35				
TL						
Source of variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit.*
Between groups	11.08041	3	3.693471	4.307022	0.043794	4.066181
Within groups	6.86037	8	0.857546			
Total	17.94078	11				

Table 6. **Difference in mean treatment degradation values by year LSD$_{5\%}$ test results at 5% significance level (Karcag, 2017–2020)**

Years/Treatments	2017–2018	2018–2019	2019–2020	LSD$_{5\%}$
0 t ha^{-1}	0.247*	0.082*	0.016	0.080
20 t ha^{-1}	0.334*	0.060	0.033	0.124
40 t ha^{-1}	0.194*	0.085	0.033	0.086
TL	1.064	1.099	0.257	1.744

Note: * indicates a significant result.

Degradation of the grassland accompanies with the change of plant composition (Jauffret and Lavorel 2003; Wang et al., 2006; Xie and Sha, 2012). Vetter (2005); Fernandez-Gimenez and Le Febre (2006); according to Liu et al. (2019) degradation of the grassland is mainly caused by changing grazing system by privatisation of the grassland.

Liu (2006) stated the typical feature of grassland degradation is decreasing plant covering. Decreasing plants is for different utilisation aims (fodder), the number of poisonous species increases (Zhang & Liu, 2003; Cui and Graf, 2009).

The speeding of recultivation by re-sowing natural grassland association and nutrition re-supply did not lead to aim, so we proved the statement, that the ancient grasslands are the children of the nature, autonomous and hardly adopt strange re-sowed grass species, Lolium perenne is not worth to re-sow.

During the coenological monitoring, it was found that, on the overgrazed area the number of species is higher, which proves the idea of Vickery et al. (2001), the grazed fields are more heterogeneous than mowed fields, which affects positively the biodiversity of the grassland (Palmer, 1992; Dufour et al., 2006).

That periodical changing the one-sided grazing by mowing can make the composition of the grassland association more balanced and decrease the appearance of weeds. We found similar results on the grazing areas to Huber et al. (1995) and Czóbel et al., (2012), the covering rate of the plants which are avoided by the animals is increasing year to year, so degradation is growing. These results confirmed the recognition, that the monitored area is degraded because the degradation numbers according to SBT showed values above 1, while on the area where grazing was exchanged by mowing, degradation is reversible.

CONCLUSIONS

With the suppressing of grazing with shepherds in Hungary free grazing and grazing in gardens can be intensify, which take place next to the ranch because of convenience. Because of the lack of qualified employees one part of our grasslands can become bare caused by overgrazing. Non-potential weeds can dominate on the area for example *Hordeum murinum*, which cause severe animal health problems.

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