STRESS EFFECT OF FERTILIZATION AND PRECIPITATION ON THE BIODIVERSITY OF RANGELAND

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Abstract: Grass yield and sward compositions of rangelands are determined by soil nutrient status, summer rainfall (potential moisture deficit). There are two very important concepts of sward composition. One is that pasture composition moves toward equilibrium with the environment. The second is that botanical composition is a dependent variable and not a driving variable in the climate – soil – plant - animal system. Sward composition reflects what happening to the system. With financial support from the "GAK, JUHFETA4" an experimental trial has been carried out at the grassland of AWASSI Rt. The objective was to investigate the relative effectiveness of fast-acting fertilizers and farm manure treatment to control the changes of rangeland sward composition by the effect of summer rainfall. There were control, and five fertilizer 100kg N ha^{-1}, 100kg P ha^{-1}, 100kg K ha^{-1}, 100kg NP ha^{-1}, 100kg NPK ha^{-1} and one farmyard manure 10 t ha^{-1} $year^{-1}$ treatments. The botanical composition and the biodiversity components of the plots were recorded three times every experimental year. The diversity of the flora was reduced by the introduction of grassland fertilization, and was improved by the farmyard manure application.

Keywords: rangeland, stress effects, diversity, precipitation, fertilization

Introduction

The botanical composition of natural grasslands is a result of several ecological effects. (Frame, 1992, Szemán, 2007). Factors determining the diversity of species are characteristics of the soil, nutrient and water supplies, (Stekauerová, et.al. 2007) the terrain and precipitation. (Centeri *et.al.* 2007, Szabó *et.al.*,2007, Várallyay, 2007, Haynes, et.al.1993, Tasi, 2007, As the plant stand reaches its climax, the botanical composition of the grassland can be considered permanent, because it reaches equilibrium with its environment. This stabile state changes due to external interventions. Gradual changes result in an even reaction. Occasional (Szemán, et.al.2007, Penksza, et.al.2007) yearly changes, however, can develop stress in the botanical composition and diversity of the plant stand. The strongest environmental effect is represented by grassland management (Benyovszky, et al. 2007) as an activity of agricultural production. Grassland management is a process based on grassland plants as biological bases, utilizing the crop produced through grass production (Rutkoviene, et.al. 2007, Haynes, et.al 993) by farm animals.

Of all procedures of production technology, manuring changes (Kádár, 2007) the ecological nutrient level of the soil and through this the botanical composition and biodiversity of grasslands. (Herczeg, et.al. 2006, Pajor, et.al. 2007) Nutrient supplies can either be artificial fertilizers or manure. The yearly changing dose of nutrient supplies (Csatho, et.al. 2007) presents a stress for the plant stand, but original plant composition returns as fertilizing is discontinued. Among the active agents, nitrogen, phosphorus and potassium play major roles in the change of biodiversity determined by precipitation (Ľubomír – Hallett, et.al. 2007) conditions.

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Materials and methods

Diversity and cover of grass species were determined on species rich natural grasslands in Bakonszeg which neighbour the Hortobágy, during two growing seasons characterising different summer precipitations (rainy summer of 2006 and dry summer of 2007: 570 mm and 370 mm of annual rainfall, respectively). The top layer of the meadow solonetz soil was of clay texture, with a humus content of 4-5%.

Seven fertilization treatments (Table 1) were used. The basic plot size of fertilization was 5x5 m and was replicated three times.

The botanical composition and the biodiversity of the plots were recorded three times in each experimental year.

The effects of nutrients have been influenced by precipitation. Depending on the weather, we can talk about rainy, rainfall deficient and dry (arid) years. Years when the amount of rainfall deviates from the average either in a positive or a negative direction, impose an abiotic stress effect on the biodiversity of grasslands, this is why we examined the effect of the 2006 rainy summer (570 mm) and 2007 year dry summer (370mm) on the effect of artificial fertilizers and manure.

Results and discussion

The botanical composition of the grassland included first rate bottom and top grasses, secondary *Festuca species*, perennial and annual forage *legumes*, as well as valuable *dicotyledons* and *weeds*.

Table 1. The growing season and annual precipitation and fertilizer treatment on Sward composition changes

Species Groups	Species number under fertilization treatments*						
	0	N	P	K	NP	NPK	SM
The 2006 growing season (570 mm annual precipitation)							
Grasses	12	12	12	12	12	12	12
Forage legumes	3	1	3	2	2	1	3
Salt-loving annul legumes	8	0	8	8	3	0	8
Forbs	7	5	7	7	6	3	7
Weeds	3	4	2	2	4	4	4
	33	22	32	31	27	20	34
The 2007 growing season (370 annual precipitation)							
Grasses	12	12	12	12	12	12	12
Forage legumes	3	0	2	2	3	3	3
Salt-loving annul legumes	0	0	0	0	0	0	0
Forbs	2	2	3	2	3	3	5
Weeds	1	2	2	1	3	3	4
	18	16	19	17	21	21	24

0 = unfertilized; 100 kg ha-1 of nitrogen (N), phosphorus (P), potassium (K), both N and P; NPK = 100 N + 100 P + 200 K; SM = sheep manure 10 t $ha^{-1}x3year^{-1}$; P and K were calculated as P_2O_5 and K_2O.

The botanical composition (*table 1.*) of control plots consisted of 12 grass species, 3 perennial legumes, 8 annual legumes, 7 other dicotyledons (forbs) and 3 weed species. As a result of nutrient applications, the number of species in the grassland changed.

On the control plots, precipitation caused an increase in the number of species, while the lack of precipitation caused a decrease. This change has been indicated primarily by annual leguminous species.
The number of grass species was not influenced by either nutrient supply or the precipitation in a given year. The botanical cover of some species increased by the use of nitrogen, while potassium and phosphorus did not have the similar effect. The effect of fertilizers was enhanced by rainy years, and reduced by dry years. In dry years, the decrease in the botanical cover of primary grass species was significant, while the cover of secondary grass species did not increase significantly in rainy years either.
The use of nitrogen resulted in a decrease in the number of perennial leguminous species. The application of different fertilizers caused a change in the number of annual legumes only in rainy weather. When using nitrogen, the number leguminous species decreased or they disappeared. Applying manure, phosphorous or potassium promoted their appearance in grasslands. In dry weather, legumes disappeared from all plots.
The use of artificial fertilizers decreased the number of dicotyledonous species in the grassland. This change was reinforced by the lack of precipitation. Some species disappeared, while some species appeared. Rainy periods caused an increase, while deficiencies in the rainfall caused a decrease in the number of species of dicotyledons on the treated plots.
The number of weed species decreased on plots where artificial fertilizers were applied, while it increased on plots where manure was applied. *Convulus arvensis* could only be identified on plots where nitrogen fertilizers or manure was applied. The change of precipitation had no effect on the number of weed species.

Conclusions

Results (*table 1.*) of our research clearly identify stress effects on plants. The application of fertilizers did not have an effect on the number of grass species, therefore the nutrient supplies with the doses and active ingredients applied in our trial cause no stress effect for grasses. The change in the precipitation of each year caused no changes to the number of grass species either, so it can be concluded that grassland species tolerate the abiotic stress caused by the changes of weather. This proves the fact that extreme weather effects can regularly occur in the area.
The stress tolerance of perennial legumes towards nitrogenous fertilizers is enhanced by surplus precipitation.
Annual leguminous species do not tolerate stress caused by artificial fertilizers. Abundant precipitation causes no stress for legumes, while dry weather is not tolerated by these species.
The number of weed species remained unchanged in grasslands, but their botanical composition changed as a result of stress caused by nitrogenous fertilizers. Depending on the type of active ingredient used, certain weed species disappeared, while others appeared.
The application of manure improved the number of species, therefore it did not have as strong a stress effect as active ingredients applied in the form of artificial fertilizers.

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