

**PRODUCTION EXAMINATIONS ON PLANT ASSOCIATIONS OF  
GRASS-LANDS WITH SOLONETZ SOIL  
I. EFFECT OF CLIMATIC AND SOIL FACTORS ON DRY MATTER,  
CARBOHYDRATE AND NITROGEN CONTENTS OF ARTEMISIO-  
FESTUCETUM PSEUDOVINAE**

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Included in the synoecological research program of the halophil vegetation of Pannonicum some investigations of production biology were made in 1968 on sodic grasslands; these investigations were connected with the International Biological Program. In Hungary the total area of halophil soil amounts to nearly 0,5 million hectares, the synoecological conditions of which are but partly known. In order to secure a proper fodder basis the intensified exploitation of these areas and the increase of the production of phytocoenoses become more and more urgent. Since the production of the plant stands is considerably influenced by climatic and edafic factors, our investigations were aimed at analyzing the effect exerted by these factors on solonetz grass associations. Within the total production the predominant species were particularly examined, since the environmental factors exert an unequal effect on the various species. The present paper describes the investigation results achieved on the *achilleetosum* stands of *Artemisio-Festucetum pseudovinae* growing in the highest zone of the solonetz steppes.

**Materials and Methods**

The investigated area was the large pasture of Csanádpalota, some 50 km. to the east of Szeged (Fig. 1). Beginning with April 1968 the surveying and the gathering of material were repeated every month. Simultaneously with our investigations the quantitative and qualitative changes caused by various fertilizer doses were also evaluated (Ábrahám-Bodrogközy, 1968. Pro to the laboratory analysis of the gathered material it was kept in sachets in a refrigerator so as to enable the water contents to be exactly determined. The material used for the analyses of contents was fixed within 3 hours after the gathering, at 105 C°, and desiccated up to a weight stability at 70 C°.

The total carbohydrate contents were determined with 2 per cent hydrochloric acid after 2 hours hydrolysis in hot water bath by means of the phenol-

sulfuric acid method according to Dubois et al. (1956). Photometry was made at 400 nm on a MOM 360-type photometer. The standard curve was plotted with pa saccharose.

The total nitrogen contents were determined with a minor modification (Horváth, 1965) of the method of Kelly et al. (1946) after decomposition in cc.  $H_2SO_4$ . Photometry was made at 400 nm on a MOM 360-type photometer. The standard curve was plotted with pa ammonium chloride.

The overground biomass production was measured at the full development stage of the plants (middle of June) with help of the three-dimensional overground production calculation we have successfully employed for years (Bodrogközy-Harmati, 1966). The biomass evaluation per season or per month, as suggested by Boer (1962) and others, belongs to our future tasks.

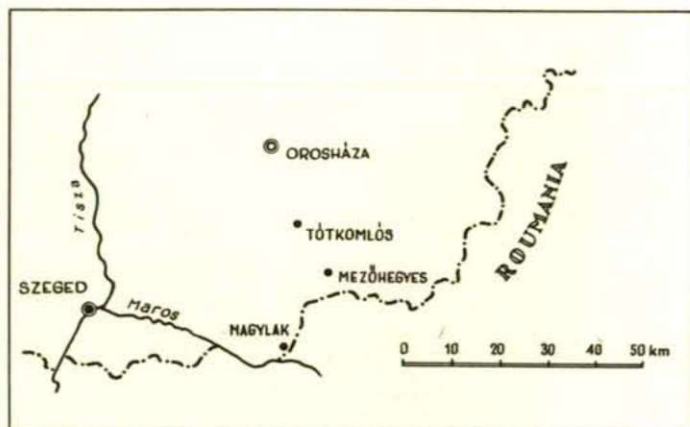


Fig. 1. Area of investigation and site of the meteorological stations.

Data of the nearest meteorological stations (Mezőhegyes, Tótkomlós) were used for the evaluation of the climatic factor (rainfall, daily average temperature as well as maximum and minimum values, number of sunny hours, etc.), while the value of the radiation energy ( $\text{cal.cm}^{-2}\text{sec}^{-1}$ , measured with a Robitsch-type overall actinometer) was made available by the Climatological Institute of our University. Since there was hardly any difference between Szeged and Tótkomlós as far as the duration of sunshine was concerned, the energy values of radiation measured in Szeged could be fairly utilized in our investigations.

In order to analyse the effect of the soil factors the plant sampling was always combined with the exploration of soil profiles as far as 70–80 cm. depth. The humidity and granular size (graded to 6 fractions) of the soil as well as the concentration of Na salts were determined at every 10 cm. level according to the methods described by Ballenegger et al. (1962). Deeply situated subsoil water was left out of consideration because its effect is improbable (Ellenberg, 1952; Weise, 1954; Dancau, 1963).

## Results

Due to the more favourable conditions of soil oecology (Ábrahám, 1967, — carbonate solonetz becoming steppe-type in deeper layers, the  $B_1$  level is situated under 20 cm., low Na salt level of the leached A level) the glycophil and pseudohalophil species come into prominence with this type of *Artemisio-Festucetum*.



The stands usually include the following species:

*Festucion pseudovinae* species:

*Festuca pseudovina* v. *salina*, *Scorzonera cana*, *Limonium gmelini*, *Ranunculus pedatus*, *Trifolium retusum*, *Trifolium angulatum*, *Artemisia monogyna*.

*Agrostion* species:

*Taraxacum officinale*, *Alopecurus pratensis*.

Neutral species:

*Cynodon dactylon*, *Gypsophila muralis*, *Achillea collina*.

*Festucion sulcatae* (*rupicolae*) species:

*Scilla autumnalis*.

Even in case of the *Achillea collina* subassociation there is a rather poor combination of species to be found. — The frequent occurrence of a preglacial loess steppe element, *Scilla autumnalis*, may be regarded as a floristical curiosity. In connection with the changing of local factors it will be reasonable to submit the specific combination to an analysis per aspects.

Medium stage of the spring aspect (date of examination: April 26th 1968).

Climatic factor: The weather of the period prior to the gathering was substantially different from the average of many years. In the first two months of the year the number of sunny hours and the quantity of precipitation remained far below the usual values. Beginning with February the temperature was rising quickly; a daily average temperature of more than 10 C° was quite common. In March the number of sunny hours increased suddenly, with little rainfall.

Soil factor: In the profile of the carbonate-type grassland solonetz soil there was a thick A level, followed by a well developed columned level. It was only under 30 cm. where the total salt content surpassed 0,2 per cent, while it was somewhere about 0,1 per cent in the A level. The A level can thus not be considered as sodic soil.

Flora: The grass association was composed mostly of xero- and glycophil species. Relying upon character species it was found to be a transition between the associations *Achilleo-Festucetum* and *Artemisio-Festucetum pseudovinae*. The leached A level of a considerable thickness permits even several glycophil species to get established if they are able to adapt themselves to xerotherm local conditions.

The appearance of the *Agrostion* species by blades — such as *Alopecurus pratensis*, *Taraxacum officinale* — permits to conclude on a development from slightly sodic moorland. (Bodrogközy, 1960).

The effect of xerotherm local conditions is reflected also in the relative dry matter contents of the species. However, there are considerable differences between the species. So for instance the deeply rooted species, such as *Scorzonera cana* and *Taraxacum officinale* are poorer in dry matter, while *Festuca pseudovina* with no deep roots has a higher content of dry matter (Fig. 2).

*Scorzonera cana* has the highest N content, three times as high as that of *Taraxacum*. An inverse situation may be found in regard to carbohydrate contents (Fig 2). *Festuca pseudovina* has an outstanding carbohydrate content, which might probably be explained with the fastly developing raw fibre content.

After-stage of spring aspect (date of examination: May 9th 1968):

Climatic factor: Due to the effect of rainfall, to the rising number of sunny hours and to the temperature maxima of about 30 C° before the gathering, it had hardly any effect.

Soil factor: Beginning with the spring aspect, the little atmospheric precipitation caused a definite xerophil character. As far as the depth of 20 cm. the soil humidity was less than 10 per cent. Due to the physical structure of the soil even this may be regarded for the most part as slack water.

Flora: The combination of species has slightly changed. The rainfall of 50 mm. prior to gathering has mainly increased the water content of *Festuca pseudovina* (cca. by 15 per cent), and to a smaller extent that of *Scorzonera* and *Taraxacum*.

The total N content of *Festuca* remained unchanged, that of *Achillea* has increased and that of *Scorzonera* has decreased. Carbohydrate contents have generally increased, particularly in case of *Festuca* (cca. by 15 per cent).

Early stage of summer aspect (date of examination: June 19th 1968):

Climatic factor: Beginning with the middle of June the number of sunny hours has considerably increased and was for several days even higher than 11. (It represented actually 95 per cent of all possible sunny hours.) Temperature was rising simultaneously. The third heat-wave of the 1968 vegetation period has developed immediately before the examination. The temperature maxima were about 30 C° and the minima were not lower than 20 C°. Increased transpiration was not compensated by rainfall since there was no important precipitation during the three weeks before the examination. (There was 40 mm. of rain between the two gatherings.)

Soil factor: The change in total salt contents was insignificant, but soil humidity decreased to 5 per cent in the upper layers. Mosaic-like cracks appeared on the soil surface.

Flora: Lively green even at the end of May in other years the steppe gradually dried out already from the beginning of May 1968 on. The vegetation had a yellowish greenish brown colour. *Taraxacum*, for instance, dried completely out and only the deeply rooted *Limonium gmelini* started growing. Due to the drought the plant association became poor in species.

The water content of the biomass decreased considerably; that of *Festuca pseudovina* was only 20 per cent and even that of the intensely



growing and lively green *Cynodon dactylon* was not more than 50 per cent.

The species *Scorzonera* and *Achillea* dried out to a lower extent (the comparatively higher humidity content of *Scorzonera* may be explained, among others, by the fact that most of the plants remained in the vegetative state on account of the drought).

While the relative dry matter content increased, the total N content diminished in every species. The slightest decrease was found in *Achillea*. It was rather remarkable that *Festuca* with many of its leaves becoming yellow had almost the same total N content as the lively green *Cynodon*.

As compared with the previous examination, the total carbohydrate content hardly presented any change.

After-stage of summer aspect (date of examination August 1st 1968):

Climatic factor: Warm sunny weather since the last examination. Soil factor: The total salt contents remained essentially unchanged. Due to nearly 80 mm. of rain in July the humidity of the superficial layers increased from 5 to nearly 20 per cent.

Flora: Until the rains came in the middle of July most of the vegetation became latent. (Even almost 40 per cent of *Limonium gmelini* was damaged.) Due to the temperature decreasing simultaneously with the rain (maxima of about 20 C°) the vegetation was restored to life. So the examination of August 1st presented almost the same species as that of June. Due to the regermination and the higher humidity of the environment, however, there was an important decrease in the dry matter content of the biomass to be observed.

The total N content of every species increased conspicuously and presented the highest values observed during the whole vegetation period. On the other hand, there was a decrease of the total carbohydrate content in every species except for *Cynodon dactylon* (especially in *Limonium* and *Festuca*).

Early stage of autumn aspect date of examination: September 5th 1968):

Climatic factor: The weather of the 35 days passed since the last examination was characterized by favourable rain, light and temperature conditions.

Soil factor: The total salt contents continued to be unchanged. In spite of the sufficient amount of rainfall the soil humidity decreased in this period by some 50 per cent (this was probably the consequence of the considerable water uptake caused by the intensive germination and growth of the plants).

Flora: With the reappearance of the *Taraxacum* and of some *Papilionaceae* species the specific combination was changed. Due to the favourable local conditions the water contents of the plants generally increased. This increase was particularly important in *Cynodon* and *Festuca*.

Among all of the examined species *Scorzonera* was the only one with unchanged water content.

Particularly in case of *Limonium* and *Achillea* there was a considerable decrease of the total N contents. However, the decrease of N contents was less important in the grasses yielding the bulk of the phytomass, especially in *Festuca pseudovina*. Except for *Limonium*, the decrease of total carbohydrate contents was equally important.

After-stage of autumn aspect (date of examination: October 11th 1968):

Climatic factor: The first two-thirds of the 35 days passed since the September gathering were extremely rainy (nearly 80 mm.). Notwithstanding, the number of sunny hours was rather high.

Soil factor: As compared with the last examination the soil humidity has increased, but in spite of the heavy rainfall it was hardly higher than 15 per cent even in the upper soil layers.

Flora: The specific combination hardly changed; the percentage of the *Papilionaceae* increased, while *Taraxacum* disappeared. The dry matter content increased considerably in most of the species, except for *Festuca*. Especially the relative dry matter content of *Cynodon* grew larger (cca. by 40 per cent).

As compared with the results of the September examination, the  $\gamma$ /mg values of the total N contents decidedly decreased in every species, while those of total carbohydrate contents presented a considerable increase.

### Summary

Included in the International Biological Program, synoecological and production investigations have been carried out in the vegetation period 1968 on sodic grasslands to the south-east of the river Tisza. These investigations were concentrated on the associative conditions of the *Limonium* facies of *Artemisio-Festucetum pseudovinae* as well as on the overground relative dry matter, total N and carbohydrate contents of the species, in the function of climatic and edafic factors. The following conclusions were reached:

1. At the beginning of, and prior to, the vegetation period the weather resulted in dry and warm local conditions; their effect was intensified by steppe-type solonetz grassland soil with saline deep layers.
2. The plant association was poor in species, most of the ephemeral *Trifolium* species characteristic of sodic soil were missing (*T. retusum*, *T. angulatum*, *T. striatum*), and therefore the investigations were mainly restricted to *Festuca pseudovina*, *Cynodon dactylon*, *Scorzonera cana*, *Achillea collina* and *Limonium gmelini*.
3. The total salt contents of the upper 60 cm. soil layer hardly changed during the vegetation period and was unaffected by rainfall.
4. The water contents of the upper soil layers was more intensely influenced by the condition of the flora than by rainfall.



5. The relative dry matter contents of the examined species changed in a considerable degree and unlikely to each other. In *Festuca* this change was as high as 100 per cent. The relative dry matter content is in close correlation to the rainfall conditions. The slightest change can be observed in the relative dry matter contents of deeply rooted species (*Scorzonera*, *Limonium*).
6. Total N contents reach a peak value during the regermination at the end of summer and are particularly high in *Papilionaceae*, *Limonium*, *Scorzonera* and *Achillea*.
7. The change in the total carbohydrate contents was less important. Outstanding carbohydrate contents were observed at every examination in *Festuca pseudovina* and *Cynodon dactylon*.
8. In general the total N and carbohydrate contents changed in opposite sense.

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Fig. 2. Change of the nitrogen and carbohydrate  $\gamma/\text{mg}$  of the total dry-material content over soil surface of the species *Artemisio-Festucetum pseudovinae achilleetosum* during the vegetation period of 1968, in the proportion of the changes of climatic and soil factors.