University of West-Hungary
Forestry Faculty

Theses of the doctor's dissertations

Relationships between the so-called "cseri" soil type and its forest stands in the "Kemenesalja" forest region after the example of Ivan

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Introduction and target of the work

Forest decline at the end of the last century and other difficulties in forest management called the attention of managing organs and authorities to the problems of marginal site conditions. These problems turned up mostly on “cseri” and cemented gravel soils in the forest region “Kemenesalja”. The “cseri” soil type is a special one, which had been mentioned long ago in the literature, but its characteristics haven’t been investigated in detail and hasn’t been either ranged among the soil types of forest soil classification until the issue of the Guide for Forest Planning in 2001.

So, comprehensive knowledge on the features of this soil type was aimed by the author’s research. The following items were set for the research program:

- Description of the morphological traits of this soil type with its chemical and physical properties as well as its mineralogical composition.
- Investigations on the composition of mesofauna in the soil and its quantitative relations.
- Description of the relationships of nutrient contens in the soil and min trees species on it.
- Promotion the afforestations on “cseri” soils by amelioration techniques.
- Relationships between soil features and growth of forest stands.

Methods applied

As the first step the site conditions of a forest-covered area of 200 ha size were mapped. This area was divided to 4 separate blocks. The usual soil investigations were supplemented with pF measurements as well as the mineral composition of the soil horizons were investigated with derivatographic and roentgen-diffractometer techniques. Statistic methods helped to find the relationships between nutrient contents in the soil and in the leaves of dominant tree species. Biologic activity of the soil was determined by quantitative parameters and diversity of mesofauna. Productivity of soil types and subtypes was quantified with yield characteristics of the forest stands. Soil amelioration investigations were also carried out to find the best ways of soil tillage and nutrient supply for the promotion of successful afforestations.

Scientific results (Theses)

1, Based on the data of four meteorological stations near the experimental area a cooler period from the 1950's to the 80's was revealed on this region, furthermore a relatively high humidity was dominant up to late 60's. So the afforestation conditions in the sixties were somewhat favourable in the contradiction with the subsequent decades. In the following period (eighties and nineties) the humidity of growing season decreased while the annual mean temperature increased. This period didn't provide good conditions neither to establish new forest stands nor to regenerate the existing stands. The problems appeared mostly on the lightly cemented

gravel soils and on the “cseri” soils of shallow rootable depth. According to the meteorological data the highest precipitation reduction was measured at the meteorological stations of Kapuvár and Lövő. It was more than 100 mm in the growing season meaning a reduction of 30%. Taking the low water-holding capacity of the above-mentioned soils into account, the aim of management and the list of plantable tree species need to be reconsidered

2, There was a statistically justifiable interrelationship between depth of ground-water table in April and October and the precipitation amount in the growing season and in the winter period, respectively. At the onset of nineties the depth of ground-water table decreased as a result of heavy drought period and we can suppose its effect on the forest decline in the years concerned.

3, A complete site survey and soil map was made on an area of near 200 ha. This work – supplemented with other investigations – was the base to the proposals for the introduction of “cseri” soils into the forest soil type system as well as the separation of its three subtypes and their description. So, the site conditions were reassessed for the area investigated.

4, High quartz content was found in the silt + clay fraction of these soils which contributed to the low productivity of “cseri” soils. Another finding was that the dominant clay mineral in “cseri” and gravel soils was the illite, by which the loosened soil conditions might easily be compact again, In brown forest soils of the region the dominant clay mineral is

the smectite, which is able to hinder the compacting of the soil by its high swelling and shrinking abilities.

5, pF investigations revealed a very low available water content in the “cseri” soils and slightly cemented gravel ones, so the drought tolerant Scotch pine stands can be supplied with water only for 20-25 days without further water input. This finding points to the fact, that the quantity of precipitation may have decisive importance for the vegetation, but its distribution and regularity cannot be either neglected. The available water source of brown forest soils of the region is three times as high as in the aforesaid soil types, so they are able to meet the water demands of forest stands. The limitations of the application of both the parameter assessing and point assessing functions were also determined.

6, Investigations on the mesofauna of “cseri” soils have proved the poor occurrence of Oribatidae and Collembola species, which points to a compact, airless soil condition. So the biological decomposition is very slow, the mineralization limited and release of necessary nutrients is restrained. This restrained nutrient turnover in “cseri” soils is certainly one reason of poor nutrient supply in them.

7, Statistically verifyable interrelationships between the available magnesium and calcium of the soil and the available iron and zinc could be proved. There was close correlation between the last two elements and the hydrolytic acidity, which can be explained by the changing solving conditions due to pH.

8, The “cseri” soils are of poor nutrient content and this fact has its influence in the nutrient supply of trees. According

to leaf analysis the plants have very low nutrient content, which is near to the lower level of the proper supply for the most important macro and meso-nutrients. As for the micronutrients those are in high quantity present for which the low pH is favourable. With the exception of copper the nutrient contents in oaks are significantly different from those in conifers. There is near three times as much calcium in oak leaves as in pine needles. On acid soil conditions like these investigated this fact has a great importance as it gives preference to the deciduous tree species, on this way more calcium can be added to the upper, biologically more active soil layers improving the soil structure and increasing the pH together with the availability of the most important nutrients. As for the micronutrients there were significant differences between oaks and pine, the former species are accumulating more aluminium in the leaves while the later ones more iron and manganese.

As the result of analysis in trees of various age it has turned out, that phosphorus and potassium contents in the leaves are decreasing with tree age (reutilization), while the calcium, iron, magnesium contents are increasing. In pines the copper and magnesium contents decreased with increasing tree age, while in Austrian pines these elements slightly increased.

On ground of these findings the author suggests that priority has to be given to oaks against pines.

9, The soil amelioration experiments – both the amelioration and the nutrient supply – show positive impact on the nutrient content of plants. Greatest difference was found among the effects of various soil preparation techniques. This refer to the necessity of allaying the compactness of soil, the consequence of which is improved mineralization and better

nutrient and water uptake and these all may accelerate the root growth. Deep-loosening as soil preparation is the best way for successful afforestations. However it increases the costs of soil preparation, but it may be compensated by the less beating up costs and faster growth.

10, Interrelationships among nutrients in plants were investigated with multivariate and bivariate analysis. The strongest members performed by multivariate technique could be shown with bivariate technique, too, but the former method promoted to show the effects of such elements, too, which were not expressed enough with bivariate analysis.

With the help of main component analysis two functions were developed. In the first one macro- and mesonutrients ere ranged with the exception of calcium plus aluminium and zinc with negative sign, while the other microelements investigated together with calcium were ranged into the other one. This refers to the close correlation among macro- and mesonutrients and also shows the negative effects of the above mentioned elements, by aluminium and zinc accumulation.

11, The plant and soil investigations resulted in several significant relationships. These could be experienced not only in case of nutrient content in the soil and plant, but between pH and nutrient content, too. These all indicate to an improved nutrient supply of forest stands by melioration activities.

12, With discriminance analysis the importance of nutrient demands of site could be proved for the nutrient content of plants. This is so sharply expressed that the origin of a certain plant can be localized within a district by its nutrient

composition. The reliability of this method can be checked with oaks as the whole investigation area is consisted of four separate blocks. It has proved to be 97% for oaks while 92% for pines based on their 1-year and several year old needles.

13, Most part of Turkey oak stands can be ranged into the yield class III, but their mean diameters haven't attain that in the yield table. The younger stands perform poorer growth than the old ones, the reason which can be the fact that the younger stands are mostly of abused and abandoned agricultural lands while the old ones are grown on traditionally forest covered lands.

Such differences couldn't be found for Scotch pine stands of various age as the stands investigated had been mostly planted on low quality "cseri" soil conditions. The stands can mostly be ranged into the yield classes III and IV, but their rotation age falls behind the values in the yield table for their unsound health.

14, Investigations in even-aged Scotch pine and Turkey oak stands on the biological top-height conditions revealed some similarities among them if the soil had 50% or more gravel content. On the contrary the Turkey Oak performed more vigorous height growth than the Scotch pine depending on the thickness of rootable depth in the soil. Thus, sites of thicker rootable depth can be less exploited by the Scotch pine than Turkey oak, so the latter is recommended for such sites.

15, In Scotch pine stands it is the pine shot moth that is the most dangerous biotic pest. The proportion of damaged stems exceeded the rate of 30% on sample plots. The quantity of dead wood was differing by soil types. Highest rate were

found on slightly cemented gravely soils with a rate of damage around 50%, while on water-logged brown forest soil its maximum was not more than 20%.

As for the Turkey oak, there were problems only with the frost cracks (55% in the stands) and stump rotting concerning about ¼ of the stem number. In pedunculate oak stands there were no serious damages.