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THE SUITABILITY OF SOUTHEASTERN AREAS OF ROMANIA FOR THE ESTABLISHMENT OF SHELTERBELTS

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Abstract

Shelterbelts proved to be important structures that provide water preservation and wind protection for humans, their activities, and crops but they also promote biodiversity, by providing a diversity of habitats for wildlife, contributing to a natural balance of harmful and useful species, and promoting biological control of pests. Shelterbelts were used since the 17th century, but their extensive use begin in the 19th century, following numerous scientific studies that proved their beneficial effects on soil and environment. As climatic and soil conditions are very specific for different regions, the impact of these factors on plants used to build the shelterbelts must be carefully analyzed prior to shelterbelts installation. The southern and southeastern plains of Romania are the regions most affected by climate change, especially drought. Because the area is outspread, with a very diverse soil cover, classified in different soil classes as cernisols (typical chernozem), luvisols (preluvosol), hydrisols (gleiosol), protisols (alluvial), etc., soil surveys are mandatory. In the present paper we try to highlight the importance of determining the soil suitability for the establishment of shelterbelts, especially for those agricultural lands prone to frequent droughts, as those in steppe areas of the Roman Plain. Soil profiles were opened, and surveys were performed, the soil being characterized morphologically and physico-chemically. For each type of soil, the soils were divided according to the main criteria for grouping the lands according to the forest suitability as: soil volume, soil thickness up to compact rock, skeleton content, texture, compaction, salinization / alkalization, humus content, slope category, surface and depth erosion, landslides, groundwater level, etc. The current study may be a model for the suitability of land in lowland areas frequently affected by drought, with similar physical and geographical conditions.

Key words: *shelterbelts, mollic gleysol, chromic luvisol, tipycal chernozem, calcaric fluvisol.*

INTRODUCTION

Shelterbelts protect the agricultural lands against the prevailing winds, but in fact these forest constructions offer a much larger range of ecosystem services (Marais et al., 2022). The intense agricultural practices used in the last century caused serious land degradation and a gradual loss of essential ecosystem services (Jiang et al., 2022). Agroforestry recently gained an increasing interest among the scientific community as a sustainable farming system, as it combines perennial woody plants with crops or livestock, chronologically and spatially distributed, for a balanced production and improved ecology (EU, 2017).

Among the ecosystem services, the water conservation in soil is one of the most important (Cârciu et al., 2019), as the wind reduction has a direct impact on reducing the evaporation of water from the soil surface and on lowering the transpiration of plants while in the winter the wind reduction translate into higher amounts of snow deposited on the lands adjacent to the shelterbelts and a lower soil erosion. Another positive aspect is creation of a specific microclimate, beneficial to cultivated plants and biodiversity. A complete network of shelterbelts, main and secondary, determined the reduction of wind speed by up to 50%, a significant decrease of evapotranspiration and the conservation of water in the soil (Andreu et al., 2008). Some studies proved that by setting up protective shelterbelts, the productive land decrease by 4% but this compensates with an increase of production by up to 35% or more, depending on the year.

Russia is considered the pioneer in fighting extreme drought using shelterbelts, as the first forests with protective role were established in 1696 in southern Ukraine, planted at the command of Tsar Peter the Great. In 1883, 80 hectares with shelterbelts were established, on the N-S direction, in the Kamennaya steppe (Vasilescu, 2004). Based on the scientific assessment Dokuchaev, agroforestry systematically expanded in the steppe zones (Chendev et al., 2015).
Shelterbelts have expanded in European countries, such as Denmark, Germany, Italy, Hungary, Bulgaria, then in the USA, Canada, Japan, etc., but never so expanded as in Russia (Musat et al., 2021).
In our country, the opportunity of using and stablish shelterbelts was first mentioned by Ion Ionescu de la Brad, in 1866, who planted the first forests on the land of his farm in Neamt County, in the period 1870-1872. Ten years later, in 1880, in Mărculești, Ialomita county, new shelterbelts were planted, followed by some in Braila County, in the period 1933-1937 on about 90 hectares (Vasilescu, 2004).
In 1960, in Dobrogea and Bărăgan Plain, one million hectares of land were protected by shelterbelts, while in 1961, 7000 km of forest protected the agricultural fields and 1400 km protected the communication routes (Costachescu et al., 2012).
As the importance of shelterbelts is worldwide recognized, the research today must propose the best adapted solutions for areas with different pedo-climatic conditions, by conducting studies of land suitability when setting up the shelterbelts, especially the suitable trees species (recommended by forestry specialists).
In the last decade, Romania made important steps in revigorating the shelterbelts establishment. As the measures implemented by the Payments and Intervention Agency for Agriculture (APIA) from PNDR 2014-2020 did not had the expected results, the current Romania’s Recovery and Resilience Plan (PNRR) aims to implement forested areas on 25000 ha by the end of 2023 and promise to reach another 31000 ha in the period 2024-2026.
In the current paper the conditions of four shelterbelts locations were investigated and characterized morphologically and physico-chemically, including the types and subtypes of soils, according to the main indicators.

MATERIALS AND METHODS

Physico-geographical conditions

The experiment was conducted in four different locations, in Southeastern part of Romania, in Orbeasca area, Teleorman County on a chromic luvisols (Figure 1), in Cunesti area, Călărași County, on a calcaric fluvisols (Figure 2), in Perișoru area, Călărași County, on a tipycal chernozem (Figure 3) and Gulianca area, Brăila County, on a mollic gleysol (Figure 4).

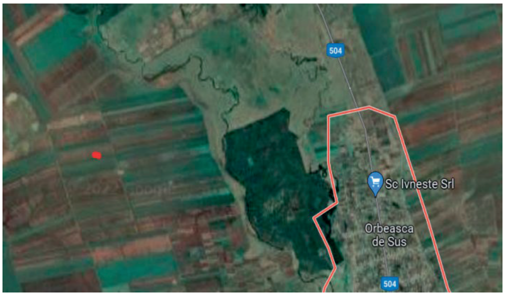

Figure 1. Orbeasca area

Figure 2. Cunești area

Figure 3. Perișoru area

Figure 4. Gulianca area

Soil analysis

Soil samples from the four locations were dried at room temperature and the soil subsamples for each of the analysis were first homogenized, then milled, and sieved with the help of a 250 µm sieve. The analyses were performed by specialized laboratories of the National Research and Development Institute for Soil Science, Agrochemistry and Environment - ICPA Bucharest.

Soil chemical properties

Soil chemical properties were determined by the following analytical methods:

- organic matter (humus): volumetric determination (Walkley-Black humidification method, STAS 7184/21-82);
- $CaCO_3$ (carbonates): gasometrical method (Scheibler calcimeter, SR ISO 10693: 1998, %);
- the nitrogen content, by calculation, based on the humus content and the degree of saturation with bases (IN = humus x V/100);
- mobile phosphorus content (Egner-Riehm-Domingo method and colorimetric molybdenum blue, Murphy-Riley method ascorbic acid reduction);
- mobile potassium content (Egner-Riehm-Domingo extraction and flame photometry);
- pH (potentiometric method in aqueous suspension at soil/water ratio of 1/2.5 - SR 7184/13-2001);
- hydrolytic acidity, extraction with sodium acetate at pH 8.2;
- degree of bases saturation V% (Kappen Schoffield method).

The following physical characteristics were determined:

- determination of granulometric fractions:
- pipette method, for fractions ≤ 0.002 mm;
- wet grinding method for fractions of 0.002-0.2 mm and dry grinding method for fractions > 0.2 mm. The results are expressed as a percentage of the material remaining after pretreatment.
- bulk density (BD): The known volume of metal cylinders (100 cm^3) at the instant soil moisture (g/cm^3) - total porosity (PT): by calculation (% by volume -% v/v);
- aeration porosity (PA): by calculation (% volume -% v/v);
- compaction degree (GT): by calculation (% by volume -% v/v), where: PMN - minimum required porosity, clay of the sample is calculated with the formula PMN = 45 + 0.163 A (% by volume -% v/v); PT = total porosity (% v/v); A - clay content (% w/w),
- hygroscopicity coefficient (HC): drying at 105°C of a pre-moistened soil sample at equilibrium with a saturated atmosphere with water vapor (in the presence of 10% H_2SO_4 solution) - % by weight (% w/g);
- wilting coefficient (WC, %, g/g), calculated based on hygroscopicity coefficient.
- field water capacity (FWC, % w/w), calculated based on Dumitru et al. (2011) formula, considering clay content (%), silt content (%), bulk density (g/cm^3), and layer depth (cm);
- useful water capacity (UWC, % w/w) is calculated as the difference between field capacity (% w/w) and wilting coefficient (% w/w);
- total water capacity (TC, % w/w) is determined as the report between total porosity (% v/v) and bulk density (g/cm^3).

For the complete soil characterization, in terms of both the physico-chemical properties of the soil and physico-geographic conditions in which the soil was formed, soil properties are represented as symbols grouped in ecopedological indicators, according to the methodology in force (ICPA, 1987; Munteanu and Florea, 2009).

RESULTS AND DISCUSSIONS

SOIL CHARACTERIZATION

A. Orbeasca de Sus, Teleorman County

GPS: $44^0\,5'\,42''$ - N and $25^0\,22'\,21''$ - E

Soil type: chromic luvisol

Landscape: plain

Use: arable

Parent material: loessoid deposits
Groundwater: > 10 m

Figure 5. Orbeasca de Sus, soil profile

Morphological characterization of the Orbeasca de Sus soil profile (Figure 5)
Ao (0-30 cm), dusty clay, with well-developed grainy structure, with shades of 10 YR 3/2 in wet and 10 yr 4/3 in dry, frequent fine roots from cultivated vegetation, non-plastic, non-adhesive, weak compact, does not effervescence;
AB (30-52 cm), clay-dusty clay, with shades of 7.5 YR 3/3 for the wet material and 7.5 YR 4/4 for the dry material, with moderately developed polyhedral structure, moderately tamped, hard in the wet state, hard in the dry state, moderately plastic and adherent, compact and moderately cemented, does not effervescence, clear straight transition;
Bt_1 (52-90 cm), clay-clay, with shades of 7.5 YR 4/3 to the wet material and 7.5 YR 5/4 to the dry material, the structure is medium and large prismatic; the material is very hard in the wet state and very hard in the dry state, very plastic and adherent, very compact and strongly cemented.
Bt_2 (90-130 cm), clay-clay, with shades of 7.5 YR 4/4 to the material in the wet state and 7.5 YR 5/6 to the material in the dry state, the structure is medium and large prismatic, frequent fine cracks; the material is very hard in the wet state and very hard in the wet state, very plastic and adherent, very compact, clear, straight;
BC (130-174 cm), medium clay loam, with shades of 10 YR5/6 for the wet material and 10 YR 7/6 for the dry material, weakly structured, slightly friable in the wet state, moderately cohesive in the dry state, presents grains of sand, with frequent spots and concretions of $CaCO_3$, weak effervescence.

B. Cunesti, Calarasi County
Soil type: calcaric fluvisols
Landscape: meadow
Use: arable
Parent material: alluvial deposits
Groundwater: > 2 m

Figure 6. Cunesti soil profile

Morphological characterization of the Cunesti soil profile (Figure 6)
Ao (0-38 cm), dusty sandy loam, light brown (2.5 y 3/2 in wet and 2.5 y 4/3 in dry), moderately developed glomerular structure, regrowth, weak biological activity, non-plastic, non-adhesive, frequent fine pores, very frequent thin roots from cultivated vegetation, gradual wavy transition;
AC (38-56 cm), medium sandy loam, yellowish brown (2.5 y 3/3 in wet and 2.5 y 4/4 in dry), moderately developed polyhedral structure, moderately tamped, with oxidation-reduction spots at the base of the horizon, frequent fine roots, clear wavy transition;
C_1 (56-82 cm), fine clay sand, yellowish (2.5 y 4/4 at wet and yellowish brown 2.5 y 5/3 at Dry), friable, unstructured, non-plastic, non-adhesive, frequent coarse pores, frequent fine roots,

moderate effervescence in the lower half of the horizon, clear straight transition;
C_2 (82-124 cm), coarse clay sand, light yellowish, marbled (5 y 5/3 in wet and 5 y 6/4 in dry), unstructured, re-loose, very friable, frequent $CaCO_3$ pseudomycelia, strong effervescence, clear straight transition;
C_3 (124-165 cm), fine clay sand, light gray (7.5 y 5/4 at wet and 7.5 y 6/3 at Dry), unstructured, wet, very friable, frequent pseudomycetes of $CaCO_3$, the presence of aquatic fauna (shells of snails and shells), very strong effervescence, clear straight transition.

C. Perisoru, Calarasi County
Soil type: tipic chernozem
Landscape: plain
Use: arable
Parent material: loessoid deposits
Groundwater: >10 m

Figure 7. Perișoru, soil profile

Morphological characterization of the Perisoru soil profile (Figure 7)
Am (0-36 cm), dusty clay, dark brown (10 yr 2/1 in wet and 10 yr 3/2 in dry), glomerular structure well developed, porous, permeable, frequent fine roots from cultivated vegetation, weak effervescence at the base of the horizon,
AC (36-68 cm), medium clay, light brown (10 YR 3/3 in wet and 10 yr 4/4 in dry), poorly developed glomerular structure in the upper half of the horizon, slightly friable, porous, aphanate, with accumulations of carbonates in the form of pseudomycelia, moderate effervescence;
Cca (68-120 cm), sandy loam dusty, yellowish (2.5 y 5/4 in wet and 2.5 y 6/6 in dry), unstructured, very friable, porous, aphanat, with accumulations of carbonates in the form of pseudomycelia and small crumbly concretions, strong effervescence.

D. Gulianca, Braila County
Soil type: Gleiosol cernic (GS-ce)
Coordinate: $45^0$26'3" - N and $27^0$31'2" – E
Parent material: alluvial deposits
Landscape: meadow
Groundwater: - 2.5 m
Use: Arable

Figure 8. Gulianca soil profile

Morphological characterization of the Gulianca soil profile (Figure 8)
Am (0-26 cm), dusty clay, with shades of 7.5 YR 2/1 at wet and 7.5 YR 2/3 at dry, moderately developed polyhedral structure, medium aggregates, wet, moderately adhesive, moderately compact, gradually wavy transition;
AC (26-52 cm), medium clay, with shades of 7.5 YR 2/3 at wet and 7.5 YR 3/4 at dry, with weakly developed polyhedral structure, small and medium aggregates, wet, weakly adhesive, weakly compact, clear straight transition;
C (52-90 cm), medium sandy loam, unstructured, with shades of 7.5 YR 4/3 at wet and 7.5 YR 5/6 at dry, clay, weak plastic, weak adhesive, clear wavy transition;

CGo (90-160 cm), dusty sandy loam, unstructured, with marbled shades of 7.5 YR 4/3 at wet and 7.5 YR 5/6 at dry, moderately plastic, moderately adhesive, wavy gradual transition;
CGr (160-200 cm), fine sandy loam, unstructured, with eggplant shades of 7.5 YR 4/3 in wet and 7.5 YR 5/6 in dry, non-plastic, non-adhesive.
Based on the morphological and physico-chemical characters of the soil types and subtypes in each of the four studied areas, their suitability for shelterbelts use was established. The following observations were made:
- regarding the edaphic volume and soil thickness up to the compact rock, all soil types identified and characterized morphologically and physico-chemically, are suitable for the first favorability class;
- the granulometric composition is generally loamy in the soils in the terrace, respectively typical chernozem and chromic luvosol, so it is suitable for Class I of favorability and those in the meadow, where the texture is clay-sandy, they are suitable for Class II;
- the physical properties of the soil in the four locations are less favorable (poor compaction), therefore suitability for Class II;
- in terms of salts, except for the area of Gulianca, Brăila County, where it was found poor saturation in high depth (over 135 cm), suitability for Class II, in the other locations, the land is suitable for Class I;
- the organic matter content is low only on the alluviosol in Gradiștea area, so the II Class of pretability and in the other three locations, the land is suitable for Class I;
- the skeletal material content, the slope and the ground cover frame the soil of the four locations to the first class of suitability;
- the phreatic level is very low (over 10 m) in the upper blind area and Perisoru, so the land is suitable for Class I and higher in the respective floodplain areas Gradistea and Gulianca, where the train falls to Class II of suitability;
- the gleization process was found only in Gulianca, Braila County (low gleization in depth), the soil being classified at Class II of suitability;
- stagnogleization processes, surface excess and floodability, were not found on any type of soil, these being classified in the first favorability class.

CONCLUSIONS

As a conclusion, at Orbeasca de Sus, in Teleorman county, the type of soil identified is suitable for the Class II of favorability only due to soil compaction, which can be intervened by pedoameliorative works (deep loosening, scarification, etc.).
At Cunesti, in Călărași County, the soil type presents some particularities (compaction, low organic matter content, generally coarse texture, weak-moderately alkaline reaction, floodability, etc.), which is why the soil falls to the Class II for Forestry favorability.
At Perisoru, in Călărași County, the type of soil being of the best quality, lends itself to the first class of favorability, for all indicators.
At Gulianca, in Brăila County, ameliorative aspects (high phreatic level, weak-moderate gleization, compaction, etc.) were found, so the land is suitable for the Class II of favorability for forest use.

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