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RESEARCH ON LAND SUITABILITY IN CUNEȘTI AREA, CĂLĂRAȘI COUNTY, FOR THE ESTABLISHMENT OF FOREST PLANTATIONS ON SANDY LANDS

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Abstract

Given the current situation regarding global warming, we intend to establish a forest plantation in the Cunești area of Călărași County, on a sandy land, prone to deflation, with accentuated climate deficit. According to the records of the Călărași Meteorological Station, four of the ten years analyzed have an average temperature of over 13 ^{0}C, higher by two degrees compared to the average of 1961-2000, of 11.2^{0}C. The physical and geographical conditions of the investigated area are characteristic for the Danube floodplain, where alluvial soils predominate, which in certain periods benefit from phreatic moistening. In order to determine the type and subtype of soil, its morphological and physico-chemical characterization, a soil profile and three pedological surveys were carried out, from which soil samples were collected on pedogenetic horizons up to the phreatic level (0-300 cm). Based on the local pedoclimatic conditions, the formula for afforestation with xerophyte species was established, with fast growth and low requirements in terms of soil trophicity.

Key words: *shelterbelts, windbreaks, mixed forest species composition, calcaric fluvisol.*

INTRODUCTION

Shelterbelts, are areas planted with different species of trees and shrubs, according to a well-drawn scheme, with the aim of forming a barrier against the winds that manifest themselves at the surface of the soil. They provide wind protection for homes, farm sites, highways, farmland and represent a diversity of habitats in which various species of wildlife find shelter. This role of biodiversity is of great importance, contributing to a natural balance between pests and beneficial species, while also increasing the biological control of pests in agricultural crops.

By reducing the wind speed, it reduces the evaporation of water from the soil surface, conserves water in the soil, by reducing capillary ascent, maintaining an even layer of snow and preventing wind erosion of the soil, etc.

Based on the studies conducted, forest curtains, although they occupy only 3-4% of the land, their presence can increase agricultural production by more than 35%. By making a network of forest curtains, with an arrangement perpendicular to the direction of the prevailing wind, we found a 25-50% reduction in wind speed, significantly reduced evapotranspiration and implicitly the conservation of water in the soil (Andreu et al., 2008; Mize et al., 2008).

Shelterbelts, capture snow by reducing the cost of removing snow from adjacent roads and improving road safety (Shaw, 1988).

A well-concluded forest curtain reduces a small part of agricultural land, and its advantages are much greater than the loss of productive land. It can be 15-20 m wide, with a 1 m shrub belt planted on both sides (Constandache et al., 2012; Szigeti et al., 2020).

The first protective curtains of the fields, dating back to 1696, in the south of Ukraine, planted on the orders of Tsar Peter the Great.

In Romania, the need to establish forest curtains was first mentioned by the great agronomist and politician Ion Ionescu de la Brad, in 1866, who established, on the land of his farm in Neamt County, in the period 1870-1872.

In 1960, selterbelts protected one million hectares of land in Dobrogea and Baragan plain, and in 1961, 7,000 km of forest curtains protected fields and 1,400 km protected communication routes (Costăchescu, 2012; Dănescu et al., 2007).

The main objectives were to prove the influence on restoring and maintaining local microclimatic conditions, to improve the soil fertility in its research stations, and to deepen research on the effectiveness and importance of forest shelterbelts. The year 2020 was one of extreme drought, with high impact on agriculture, proving the necessity of such initiatives.

MATERIALS AND METHODS

The experiment was conducted in Southeastern part of Romania, in Cunești area, Călărași County, on a Calcaric fluvisol (Figure 1). In this sector of the Danube Meadow, the meadow has wide widths, between 5-6 km and 13 km, the maximum width being recorded just east of the Grădiştea location. On the other hand, the relief is varied, it is arranged in longitudinal strips: the highest parts are the beams formed near the minor bed, then there is a middle area which in the past was partially covered with puddles and then a strip appears low with wide depression character, located towards the edge of the terraces and occupied before the damming of the lakes for the most part.

Figure 1. Cunești, Călărași County

From a lithological point of view, the territory analyzed from this location, like the entire Danube Meadow, is covered with fluvial deposits and marsh deposits. The fluvial deposits found in the Danube Meadow, which in age belong to the Upper Holocene, are up to 10 m thick. As a whole, these deposits are made up of: clay, sandy clay, loessoid clay, fine sand, sand mixed with gravel. The lithological substrate in the area of the Grădiştea location, which also represents the parent material of the soils, is made up in the upper part of an alluvial stratification with a fairly large thickness (40-45(60) cm up to 80-90 cm) and variable texture (predominantly loamy-sandy or predominantly clayey) on which the actual soils appeared and evolved, followed by an alluvial stratification.

The placement of the soil profiles was made according to the complexity of the terrain and the soil cover, according to MESP, 1987 vol. I.

Soil analysis

The samples were analysed in INCDPA Bucharest laboratories.

The following analytical methods were used to determine the chemical properties:

- 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 (TP): by calculation (% by volume -% v/v);
- aeration porosity (AP): by calculation (% volume -% v/v);

- compaction degree (CD): by calculation (% by volume - % v/v), where: MRP - minimum required porosity, clay of the sample is calculated with the formula MRP = 45 + 0.163 A (% by volume -% v/v); TP = 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. (2009) 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).

RESULTS AND DISCUSSIONS

Following the analyzes and field determinations, the identified soil is classified as Protisoils (Psamic-calcareous fluvisol) (Figure 2).

Figure 2. Calcaric fluvisol

A soil profile was carried out to a depth of 130 cm and continued with a probe to a depth of 350 cm and three soil surveys according to the soil location map. The morphological and physico-chemical description of the profile and surveys is presented below.

Profile 1 - Calcaric fluvisol
Coordonates: 44^{0}142.962"- N și 27^{0}162.141 - E
Landscape: plain
Use: arable
Parent material: alluvial deposits
Groundwater: 2-3 m

Morphological characterization
Ao (0-22 cm): medium clay sand, light brown (2.5 Y 3/2 in wet and 2.5 Y 4/4 in dry), poorly developed glomerular structure, jilav, moderate biological activity, non-plastic, non-adhesive, frequent fine pores, thin roots very common from cultivated vegetation, poor effervescence;
AC (22-48 cm): fine clay sand, yellowish brown (2.5 Y 4/3 in wet and 2.5 Y 5/4 in dry), poorly developed polyhedral structure, poorly tamped, moderate effervescence, frequent fine roots, clear wavy passage;
C_1 (48-86 cm): fine sand, yellowish (2.5 Y 4/4 to wet and 2.5 Y 5/4 to dry), friable, unstructured, non-plastic, non-adhesive, frequent coarse pores, moderate effervescence, clear straight passage;
C_2 (86-115 cm): medium sand, light yellowish (2,5 Y 5/3 in wet and 2,5 Y 6/4 in dry), unstructured, rough, very friable, without effervescence, clear straight passage;
C_3 (115-250 cm): medium clay sand, pale yellow with oxidation-reduction spots (5 Y 5/3 in wet and 5 Y 6/4 in dry), unstructured, rough, very friable, moderate effervescence, clear straight passage.
Coarse-textured soils (sands, loamy sands, sandy loams) have a large particle size and do not have great water and nutrient holding capacity. The texture of the soil is sandy loam at a depth of 0-48 cm and sandy up to a depth of 86 cm (Table 1).
The soil reaction starts from slightly alkaline in the surface horizon to moderately alkaline in the C horizon (up to 250 cm).
Humus content is an important indicator of soil fertility. Soils with low humus contents normally have a deficit of some biogenic elements, primarily nitrogen. The content and quality of humus formed in different soil types under different land use variants depend on the conditions of its formation.
It was found that the humus content varies considerably depending on the depth. At the depth of 0-22 cm, a content of 2.34% was found, at the depth of 22-48 cm, 2.15%, and the lowest amount was at the depth of 115-250 cm of only 0.11%.

Table 1. Physical and chemical analyzes for Calcaric fluvisol

Soil horizon	Ao	AC	C_1	C_2	C_3
Depth (cm)	0-22	22-48	48-86	86-115	115-250
Sandy (2-0.2 mm)	24.2	16.1	15.6	34.1	19.7
Sandy (0.2-0.02 mm)	37.6	48.4	54.4	38.2	45.4
Silt (0.02-0.002 mm)	28.4	26.3	25.2	23.6	26.2
Clay (< 0.002 mm)	9.8	9.2	4.8	4.1	8.7
Texture	UM	UF	NF	NM	UM
pH	7.66	7.92	8.41	7.24	8.66
Humus (%)	2.34	2.15	0.68	0.32	0.11
Bulk density (g/cm^3)	1.25	1.26	1.27	1.26	1.29
Total porosity (%)	53	52	50	50	48
Base saturation (V,%)	100	100	100	94	100
P mobil (ppm)	42	27	15	10	-
K mobil (ppm)	142	126	91	75	-

Bulk density registered similar values on the entire soil profile, being a very low density.
The phosphorus content is high and the soil potassium content is medium.
For the characterization of the spreading area of the calcaric fluvisol in the Cunești area, three secondary profiles were also carried out up to the groundwater level. The data resulting from the analyzes carried out highlighted the same characteristics (Figures 3-5).

Secondary profile 1 - Calcaric fluvisol
Coordonates: $44^0$140.863- N și $27^0$161.415 - E
Landscape: plain
Use: arable
Parent material: alluvial deposits
Groundwater: 3.8 m

Figure 3. Secondary profile 1

Morphological characterization of the secondary profile:
Ao (0-28 cm): medium loamy sand, light brown (2.5 Y 3/3 wet and 2.5 Y 4/4 dry), poorly developed glomerular structure, reed, poor biological activity, non-plastic, non-adhesive, frequent fine pores, very thin roots frequent from cultivated vegetation, weak effervescence, undulating gradual transition;
AC (28-56 cm): fine loamy sand, yellowish brown (2.5 Y 4/3 wet and 2.5 Y 4/4 dry), with redox spots at the base of the horizon, poorly developed polyhedral structure, weakly compacted, moderate effervescence, roots fine frequencies, clear undulating transition;
C1 (56-100 cm): fine sand, yellowish (2.5 Y 4/4 wet and 2.5 Y 5/4 dry), friable, unstructured, non-plastic, non-adhesive, frequent coarse pores, frequent fine roots, moderate effervescence in the lower half of the horizon, clear straight passage;
C2 (100-145 cm): medium sand, light yellowish (5 Y 5/3 wet and 5 Y 6/4 dry), unstructured, reave, very friable, frequent pseudomycelia of $CaCO_3$, strong effervescence, clear straight transition.

Secondary profile 2 - Calcaric fluvisol
Coordonates: $44^0$137.397- N și $27^0$166.755 - E
Landscape: plain
Use: arable
Parent material: alluvial deposits
Groundwater: 2.8 m

Figure 4. Secondary profile 2

Morphological characterization of the secondary profile:
Ao (0-28 cm): loamy sand, light brown (2.5 Y 3/3 wet and 2.5 Y 4/4 dry), poorly formed grain structure, silt, poor biological activity, non-plastic, non-adhesive, frequent thin roots from vegetation cultured, weak effervescence, straight transition;
AC (28-45 cm): medium loamy sand, yellowish brown (2.5 Y 4/4 wet and 2.5 Y 5/4 dry), very poorly structured, aggregates below 25%, poorly compacted, moderate effervescence, frequent fine roots, clear straight transition ;
C1 (45-66 cm): medium sand, yellowish (2.5 Y 4/4 wet and 2.5 Y 5/4 dry), very friable, unstructured, non-plastic, non-adhesive, frequent coarse pores, rare fine roots, moderate effervescence in lower half of horizon, clear wavy transition;
C2 (66-94 cm): fine sand, light yellowish (5 Y 5/3 wet and 5 Y 6/4 dry), unstructured, alluvial, very friable, visible fragments of aquatic fauna, strong effervescence, clear straight passage;
C3 (94-128 cm): medium sand, pale yellow (5 Y 6/2 wet and 5 Y 7/3 dry), unstructured, reash, very friable, strong effervescence, clear straight transition.

Secondary profile 3 - Calcaric fluvisol
Coordonates: $44^0$145.658 - N și $27^0$140.664 - E
Landscape: plain
Use: arable
Parent material: alluvial deposits
Groundwater: 2.9 m

Figure 5. Secondary profile 3

Morphological characterization of the secondary profile:
Ao (0-25 cm): Coarse loamy sand, light brown (2.5 Y 3/3 wet and 2.5 Y 5/4 dry), small grain structure, poorly formed, silt, low biological activity, non-plastic, non-adhesive, frequent thin roots from in cultivated vegetation, weak effervescence, straight gradual transition;
AC (25-46 cm): medium loamy sand, yellowish brown (2.5 Y 4/3 wet and 2.5 Y 5/4 dry), very poorly structured, aggregates below 25%, poorly compacted, moderate effervescence, frequent fine roots, clear straight transition ;
C1 (46-70 cm): medium sand, yellowish (2.5 Y 4/4 wet and 2.5 Y 5/4 dry), very friable, unstructured, non-plastic, non-adhesive, frequent coarse pores, rare fine roots, moderate effervescence in lower half of horizon , clear wavy transition;
C2 (70-108 cm): fine sand, light yellowish (5 Y 5/3 wet and 5 Y 6/4 dry), unstructured, alluvial, crumbly, visible fragments of aquatic fauna, strong effervescence, clear straight passage;
C3 (108-132 cm): medium sand, light yellow (5 Y 6/2 wet and 5 Y 7/3 dry), unstructured, reash, very friable, strong effervescence, clear straight transition.

CONCLUSIONS

The studied territory falls within the Romanian plain, the Danube floodplain subregion, the relief unit Drobeta-Calarasi Meadow, with an altitude of 8-13 m in the floodplain of the Danube, with a difference of 5-8 m from the terrace.

- The soil cover is consistent with the physical and geographical conditions of the area, being identified only one type of soil with zonal character, namely calcareous alluviosol;
- The soil type identified, falls to the fourth grade of quality with 34.75 points of credit worthiness for arable;
- Parental material is predominantly made up of fluviatile deposits;
- The texture of these soil units is contrasting, throughout the depth of the soil profile;
- The nitrogen content is weak-medium, represented indirectly by the nitrogen index (in), with values above 2.0% in the bioaccumulative horizon;
- The supply of mobile phosphorus, in the bioaccumulative horizon, namely the first 45 cm from the surface, is medium-good, with values of 20-49 ppm;

- Mobile potash supply, is medium, with values between 120 and 150 ppm;
- The main limiting factors of the production potential are deficient rainfall during the vegetation period, low humus content, generally coarse texture, strong evaporation during dry periods.

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