ASPECTS REGARDING THE ESTABLISHMENT OF ACACIA ON THE STERILE DUMPS FROM RECEA ŞUNCUIUŞ QUARRY, BIHOR COUNTY

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RESEARCH ARTICLE

Abstract

The ecological reconstruction of Recea Quarry will require great costs and efforts. In this paper, the success of the plantings in 2016 with acacia seedlings was analyzed. Thus, the survival rate of the seedlings planted six years ago was determined, their diameters and heights were measured by slope category, establishing twelve sample plots. Although it is observed that the diameters and heights are larger on the average slope compared to the flat and highly inclined terrain, from a statistical point of view the differences are insignificant. Regarding the survival rate of the planted seedlings, it has mean values of approx. 50%. The paper also shows the advantages of planting acacia species on these lands where the clay was extracted and recommendations are made to have better results in the future.

Keywords: (ecologic reconstruction, acacia, *survival rate*, seedlings, clay quarry
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INTRODUCTION

Ecological reconstruction is the process by which a degraded, damaged or destroyed ecosystem is restored. Sometimes, it also involves the reintroduction of some new species. (https://wwf.ro/ce-facem/ape-dulci/reconstructie-ecologica/)

Such lands are also found in Şuncuicuş-Zece Hotare area where the clay ore extractive industry experienced a large scale development in the second half of the 20th century. In order to identify the clay deposits, drilling was carried out, and their exploitation was done in two ways: by practicing mining and in the quarry, on the surface, this method greatly affecting the environment. The production of refractory clay in the period 1949-1989 evolved from 43,000 tons in 1949 to 328,700 tons in 1989, in the following period having a downward evolution, reaching 100,000 tons in 1998.

Şuncuiuş refractory clay deposit is located in the northern part of Pădurea Craiului Mountains and the exploitation perimeter is divided into two sectors: Recea, with an area of 2.89 km^2 and Bălnaca, with an area of 0.75 km^2.

The dumping of the sterile material is done by tipping from the tipper truck onto the storage surface, in small, tangent piles with a height of 1-2 m, which are leveled and compacted with a bulldozer. A technological compaction is performed after the formation of the deposits with a thickness of 45 m.

The plan to restore the environment as a consequence of the refractory clay exploitation activity in Şuncuiuş perimeter requires the mechanized leveling of the land and the planting of forest seedlings.

At the request of S.C. Bega Minerale Industriale S.A., ICAS Braşov (Forest Research and Management Institute, Brasov) drew up a project for the arrangement and stabilization of some inactive landfills through forest phyto-amelioration in 2006. Flowering ash and sycamore were proposed in the afforestation composition, which so far has proven to be an inappropriate choice because the seedlings planted in 2007 disappeared almost completely until now (***,2015). Scots pine and black pine seedlings were planted in 2008-2009 and were more successful.

The good percentage of gripping, the high ability to fix the land with a steep slope, the possibility of improving the soil through the

litter that decomposes easily, the possibility of retaining atmospheric nitrogen, but also thanks to the qualities of the wood, the high production of biomass led to the realization of this research study regarding the installation of acacia on these degraded lands from the clay quarry.

The main naturally regenerated tree species on the sterile dump are birch (*Betula pendula Roth.*), Scots pine (*Pinus sylvestris*), trembling poplar (*Populus tremula L.*), Silesian willow (*Salix silesiaca*), acacia (*Robinia pseudacacia L.*), wild apple (*Malus sylvestris Mill.*), wild pear (*Pyrus pyraster (L.) Burgsd.*) and among the shrubs the hairy brumble (*Rubus hirtus W. et K.*), the rose hip (*Rosa canina L.*), common hawthorn (*Crataegus monogyna Jack.*) and common juniper (*Juniperus communis L.*).

From its beginnings, in Romania (1852), acacia proved to be a providential species for the afforestation of the shifting sands, fixing coasts and slopes and in plantations on degraded lands, and later, as the main species in the forest curtains in the steppe and silvo regions -steppe, for the protection of fields and in the snow curtains along roads and railways (Ciuvăț, 2013). It is also considered a tree of great value, used almost exclusively for ameliorative forest plantations on the sands and light, non-calcareous soils in the warm areas of the south of the country (Doniță and Radu, 2013; Amos News, 2003).

MATERIAL AND METHOD

The research and measurements took place between August and October 2022, in the perimeter of Recea Dump (2008), near the towns of Șuncuiuș and Zece Hotare, from the commune of Șuncuiuș, Bihor County, in the northern part of Pădurea Craiului Mountains.

In 2016, acacia seedlings were planted on 2008 dump and on the plateau, which proved to be quite a good option as they gripped in good proportion, problems existing only in the locations with excessive moisture.

Approximately 10,000 acacia seedlings were planted, from Carei, Satu Mare county. The planting scheme was 2 m between rows x 1 m between plants per row, a scheme recommended for pure acacia (Florescu, 1994). These plantings were carried out on previously unprepared soils, the size of the pit, type of soil, the method of making the pits, of course, also influencing the rate of gripped seedlings (Noja et al., 2015; Budău & Timofte, 2016).

The factor analyzed in this paper was the slope, denoted by:

- P1 the test surfaces located on the slope with a gradient below5^0;
- P2 the test surfaces located on the slope with a gradient between 5^o și 15^0;
- P3 the test surfaces located on the slope with a gradient above15^0.

Recea Dump has approx. 50ha, and the acacia seedlings were planted mainly in the northern part of the quarry.

For each category of slope (variant P1, P2, P3) 4 repetitions (S1-S4) were placed, resulting in 12 square-like test surfaces of 10m x 10m, located according to table no.1 and figure no.1.

In each sample plots, the entire trees were inventoried and measurements of the following characteristics were performed:

- the survival rate of seedlings at the age of 6, expressed in number of specimens and %;
- the height of the seedlings (m) from the ground level to the top of the axis or to the highest point of a frame;
- the diameter of the seedlings in the package (cm);
- other observations: the number of acacia sprouts and root-shoots, edaphic observations, the number of branches in the first 10 cm from the ground, other naturally installed species and the number of specimens.

The trunk diameter was measured with the electronic caliper (fig. 2a), and the height with the tape measure or with a graduated telescopic rod (fig. 2b).

Table 1

Location and elevation of sample plots

SLOPE	Sample Plot Code	Coordinates, (Latitude,Longitude)	Altitude, m
P_1 $<5^o$	S_1P_1	46°55'18.9" N 22°30'39.9" E	678
	S_2P_1	46°55'10.5" N 22°30'35.7" E	721
	S_3P_1	46°55'15.7" N 22°30'40.1" E	703
	S_4P_1	46°55'24.9" N 22°30'40.4" E	664
P_2 $[5^o,15^o)$	S_1P_2	46°55'20.3" N 22°30'39.4" E	671
	S_2P_2	46°55'10.1" N 22°30'36.2" E	717
	S_3P_2	46°55'16.8" N 22°30'39.4" E	698
	S_4P_2	46°55'27.5"N 22°30'44.9"E	665
P_3 $\geq 15^o$	S_1P_3	46°55'20.7"N 22°30'40.6"E	676
	S_2P_3	46°55'10.3" N 22°30'38.8" E	715
	S_3P_3	46°55'16.5" N 22°30'40.1" E	694
	S_4P_3	46°55'21.6" N 22°30'38.9" E	669

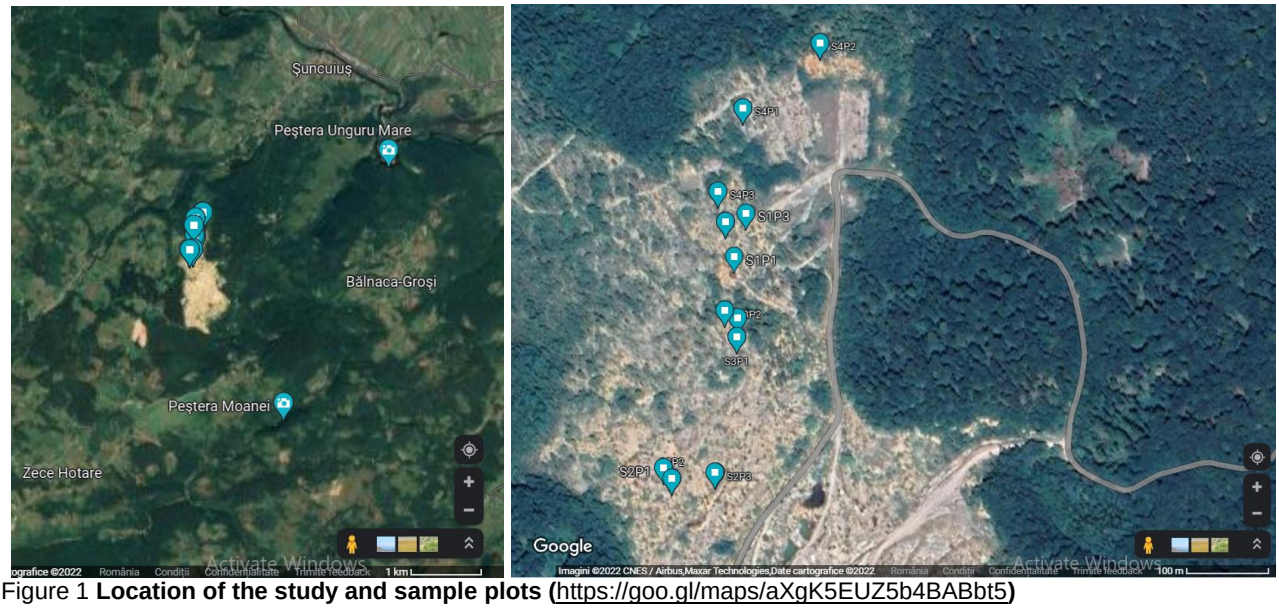

Figure 1 **Location of the study and sample plots (**https://goo.gl/maps/aXgK5EUZ5b4BABbt5**)**

a **b**

Figure 2 **Diameter measurement with a caliper (a) and of the tree height with a tape measure (b)**

For the analyzed characters (maintenance degree, plant height, diameter in the package) the arithmetic mean was determined using the well-known formula x = Σx/N.

To determine the survival rate after 6 years, the following formula was used:

$$G_m(\%) = \frac{P_{viab}}{P_{veg}} \cdot 100$$

in which: *Pveg* represents planted seedlings (50 pcs);

Pviab - existing seedlings after 6 years.

The results obtained following the performance of biometric determinations on the mentioned characters, were statistically processed through the analysis of variance, specific to the monofactorial experiments performed in randomized blocks, the significance of the differences between the two tested varieties being established with the help of the LD test and the "t" test (Student), (Ardelean et al., 2002).

RESULTS AND DISCUSSIONS

Regarding the survival rate six years after the planting of the acacia saplings under study, the data mentioned in table 2 show that out of 50 seedlings planted in 2016 per 100 square meters, only 22 survived in sample area S1P2 (the fewest) and 31 specimens in S1P3 (the most) the fall of 2022. Thus, the survival rate is between 44% and 62%.

Table 2

Number of plants and survival rate after 6 years after planting

Variant, (slope categories)	Number of plants/ survival rate for the sample plot			
	S1	S2	S3	S4
P1	24/48	24/48	22/44	23/46
P2	22/44	25/50	26/52	27/54
P3	31/62	24/48	26/52	25/50

According to figure 3, it can be seen that the survival rate of the planted seedlings increases linearly with the slope of the land, registering a percentage of 53% in the case of the lands with a steep slope of over 15°.

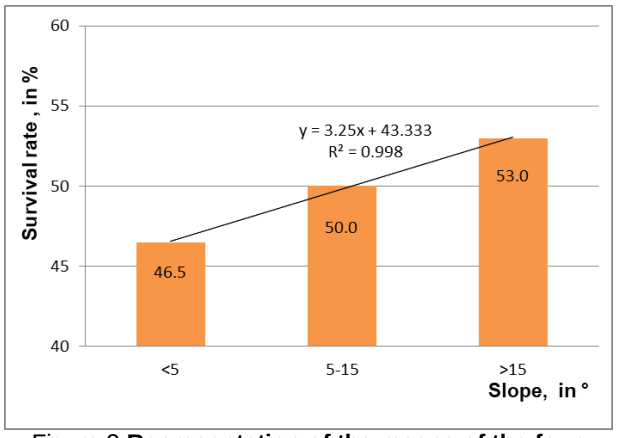

Figure 3 **Representation of the means of the four repetitions in terms of the survival rate of the planted seedlings**

These losses can be considered normal because, for acacia, in specialized works based on rigorous experiences (Costea et al., 1996), the survival rate in the first years after planting in the field varied between 19% and 94%, the values obtained in the study carried out falling between the respective limits.

If we also take into account the sprouts and root-shoots that appeared during the six years on the twelve sample areas, the average number of acacia specimens becomes:

- on the small slope (P1): 27;
- on the small slope (P1): 31.25;
- on the small slope (P1): 27.75,

which implies a 7.5% increase in acacia specimens through sprouting and root-shooting.

Regarding their mean root neck, the measured values are centralized in Table 2. For the first three analyzed surfaces, the diameters were between:

- for S1P1: 1.9-8.0cm, with a coefficient of variability of this character of 36.3%, which places the variability of that character in the "very high" class;
- for S1P2: 2.3- 6.2cm, s%= 27.1%) which falls into the "large" class of variability;
- for S1P3: 2.1-8.0cm, s%= 54.1%, which falls into the "very high" class of variability.

Table 3

Values of average diameters measured (diameter) after 6 years from planting

Variant, (slope categories)	Mean diameter for the sample plot…, in cm			
	S1	S2	S3	S4
P1	4.75	4.85	4.09	2.95
P2	4.15	5.48	3.79	4.38
P3	3.34	4.98	3.79	4.52

It can be observed that for all the three categories of slope, there is a large and very large variability in terms of the dimensions of the root neck, expressed by the values of the coefficients of variability.

The synthesis results regarding the differences between the mean root neck are presented in Table 4 and the differences between the average heights of the seedlings after 6 years from planting according to the three categories of slope on which they were planted, as well as the interpretation of these results separately for each slope category are presented in Table 6.

Table 4

Effects of the land slope on the mean root neck diameter of trees after six years of vegetation

Name of variant	Mean root neck Ø (cm)	% compared to P1	±d (cm)	Significance of difference
P1 - sample	4.16	100.0	-	-
P2	4.45	107.0	0.29	-
P3	4.16	100.0	0.00	-
DL/LSD 5 % =			1.1	
DL/LSD 1 % =			1.7	
DL/LSD 0.1 % =			2.8	

Thus, although the root neck diameter values remain higher by 7% in option 2 (slope 5-15°) compared to those recorded in variants 1 and 3, statistically the differences between the three variants are insignificant.

Regarding the average height, the measured values are centralized in Table 5. For the first 3 analyzed surfaces, the variation amplitude (A) for the heights was:

- for S1P1: A=3.5m, with a variability coefficient for this character of 35.6%, which places the variability of that character in the "very high" class;

- for S1P2: A=3.4m, s%= 34.9%, which falls into the "very high" class of variability;
- for S1P3: A=3.4m, s%= 52.3%) which falls into the "very high" class of variability.

It can be observed that for all the three slope categories, there is a very large variability in terms of the value of tree heights, expressed by the values of the variability coefficients.

Table 5

Values of average heights measured (hm) after 6 years from planting

Variant, (slope categories)	Mean heights for the sample plot…, in m			
	S1	S2	S3	S4
P1	3.23	3.30	2.73	1.99
P2	2.69	3.56	3.37	2.88
P3	2.42	3.54	2.05	3.41

Table 6

Effect of the land slope on the tree heights after six years of vegetation

Name of variant	Mean heights	% compared to P1	±d (cm)	Significance of difference
P1 - sample	2.81	100.0	-	-
P2	3.12	111.1	0.31	-
P3	2.85	101.6	0.04	-
DL/LSD 5 % =			1.0	
DL/LSD 1 % =			1.5	
DL/LSD 0.1 % =			2.5	

Thus, statistically, the differences between the three variants are insignificant, although the tree height values remain higher by 11.1% in variant 2 (slope 5-15°) compared to those recorded in variant 1.

CONCLUSIONS

Following the statistical analysis, it was found that the slope does not significantly influence the survival rate of the plants after 6 years, neither the diameter nor the height of the seedlings. However, it is observed that on the medium slope (5-15°) the diameters and heights of the seedlings are larger.

The ecological reconstruction of the degraded lands from Recea Quarry is a challenge because on the planted areas a reduction of surface and deep erosion processes was found.

Planting the areas that are not naturally regenerated is necessary and appropriate to restore the respective area, especially since a large part of these areas are located on very steep slopes exposed to erosion phenomena. On such lands, the acacia gave results, but on flat lands with excess moisture it gave poor results, as was the case with sample plots S4P1 and S3P1. Excess moisture is the factor that most negatively influences the acacia cultures on the degraded lands from Recea quarry. An increased erosion and with less good results was found in S3P3, the average diameters and heights being smaller. From the analysis of the situation encountered in the sample plots, it follows that the slopes with sunny exposure are more favorable for acacia than the shaded ones (case S2P3).

Recommendations:

- Avoid planting acacia on lands with excess moisture;
- Creating terraces around the seedlings when they are planted on land located on a steep slope;
- Provision in the environmental restoration plan for the use of a layer of topsoil that must be set aside at the time of land-stripping;
- Application of the planting scheme in “chincons” (each seedling in a row is placed near the middle of the distance between two seedlings of the neighbouring row) on the sloping lands to reduce the erosion process on the surface and avoid the formation of drainage ditches

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