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Post-disaster reconstruction and management on the sterile dumps from Steierdorf unit-Anina, Caraş-Severin

[1]Ramona Lile, [2]Sorin Stanciu, [2]Simona Martin, [3]Mihaela Moatar

[1] Faculty of Economic Sciences, "Aurel Vlaicu" University from Arad, Arad, Romania; [2] Faculty of Farm Management, Banat University of Agricultural Science and Veterinary Medicine Timişoara, Timişoara, Romania; [3] Faculty of Horticulture and Forestry, Banat University of Agricultural Science and Veterinary Medicine Timişoara, Timişoara, Romania. Corresponding author: M. Moatar, mihaelamoatar@yahoo.com

Abstract. The object of study is the reconstruction of degraded land in UP III Steierdorf and installing rehabilitating productive forest vegetation. This area was affected by excavation and storage of materials resulting from blasting, excavation, and burning bituminous rocks. The production unit is part of the group III Steierdorf southern Banat Mountains, located in western Semenic-Almaj respectively Anina Mountains. The production unit comprises the upper basin of the valley Minis, a tributary of the river Nera. The lands located on the dumps have an area of 20 ha, are located in the unincorporated town Anina, near Steierdorf neighborhood, across Anina Forestry and Forestry Directorate belongs Resita. For afforestation of degraded lands under study were mainly used species with high ecological amplitude to withstand harsh environmental conditions and shrubs. The material underlying the study is the sapling forest: *Pinus sylvestris, Eleagnus angustifolia*, *Acer pseudoplatanus*, *Picea abies* and *Robinia pseudacacia*, aged 2-3 years, according to species. They were brought from the nursery Bozovici, Forestry Bozovici. There have been 10 sample surface, in which determination has been made of the elements dendrometric, physiological measurements and the state of growth of the seedlings. The seedlings were monitored during the years 2009 to 2012.
Key Words: reconstruction, recovery, post-disaster, sterile dumps, degraded lands.

Introduction. In Romania, the current forest productivity is below the productive potential of forest sites. This discrepancy is largely due to low productivity forests, which account for 22% of the total forest area. Both forests abnormal consistency and the productive potential improper composition of the resort, require artificial interventions, recovery works, even ecological restoration. Direct measures against land degradation processes are the work of installing a consistent vegetation cover on degraded lands, especially the work the afforestation of degraded ones (Attah et al 2011).

Customized research, conducted locally, may reveal useful information regarding the adaptability of the type of forest vegetation to specific environment conditions. Normal development of woody plants is directly correlated with water use and the intensity of transpiration. Such studies make it possible to establish the way plants behavior in the local climate conditions, after being transferred from other regions, thus representing an indicator for the adaptability of the species (Visnjic et al 2009).

Material and Method. Species for afforestation of degraded forest set were chosen taking into account the achievement of consistency between their stationary requirements and field conditions, aiming to achieve the protective effect in the shortest time and for a longer period of time (Moatăr et al 2013).

For afforestation of degraded lands under study were mainly used species of great ecological amplitude to withstand harsh environmental conditions and shrubs. The material underlying the study is represented by saplings: *Pinus sylvestris* (Scots pine), *Eleagnus angustifolia* (Russian olive), *Acer pseudoplatanus* (sycamore maple), *Picea*

abies (Norway spruce) and *Robinia pseudacacia* (black locust), aged 2-3 years, according to species. They were brought from the nursery Bozovici, the radius of the Forestry Bozovici.

Research methods were specific to and consistent with the objectives. We used the following methods:

- bibliographic documentation in traditional form;
- direct observations, measurements and laboratory analyzes performed both expeditionary (route) and stationary;
- theoretical analysis (including statistical calculations) and logical interpretation of the results.

To determine the percentage of seedlings fixture were installed sample surfaces, circular form, with an area of 100 m^2 (for areas less than 3 acres) or rectangular, with an area of 200 m^2 (for areas larger than 3 acres), materialized in an imaginary rectangular grid. Determination of percentage of seedlings grip is achieved by calculating the average of each sample surface and by then the average of all surfaces (Moatăr et al 2011; Moatăr & Lăzureanu 2010).

As the percentage of grip did not correspond to a good successful crops were provided completions for 2010 losses seedlings fall into the category of technological losses, arising from the interrelation between juveniles and the environment. In the composition of afforestation we used two schemes: the first scheme is composed of *P. sylvestris* (60%), *R. pseudacacia* (20%) and *A. pseudoplatanus* (20%), and the second one is composed of *P. abies* (60%), *P. sylvestris* (20%) and *R. pseudacacia* (20%), as it is shown in Table 1.

Table 1

Composition of afforestation, number of seedlings used (Technical guidance (1) for compositions, schemes and technology of forestry regeneration)

u.a.	*Forest area (ha)*	*The afforestation composition*	*No. of seedlings/ha*	*No. of seedlings/forest area*
2E	4.8	6PIN2SL2PAM	5.000	24.000
4D	0.1	6PIN2SL2PAM	5.000	500
4E	0.1	6PIN2SL2PAM	5.000	500
4F	1.0	6PIN2SL2PAM	5.000	5.000
5C	1.2	6PIN2SL2PAM	5.000	6.000
5G	0.1	6MO2PIN2SC	5.000	500
8D	9.8	6MO2PIN2SC	5.000	49.000
8E	0.3	6MO2PIN2SC	5.000	1.500
9D	0.4	6MO2PIN2SC	5.000	2.000
25D	2.2	6MO2PIN2SC	5.000	11.000
Total	20			100.000

Results and Discussion. We predicted achievement of cleansing works once a year, in June 2010 (Table 2), June 2011 and June 2012, and revisions were made in the spring, along with making additions, that in spring 2010, spring 2011 and spring 2012 (when we did not carried works, because the clamping percentage of seedlings was very good).

The review was conducted on the entire area of the surface 10 for improvement. The clamping percentage of seedlings was not good, so we did carried works (Table 3).

Vegetation period (average daily temperature > 18°C) begin to improve the perimeter or around 5.05 and ends in the second decade of October. Average temperatures during this period are between 12.9-15.1°C (Stanciu & Tabără-Amânar 2011).

The annual growth of seedlings depends of their vegetative state (Table 4). It can determine the status of their vegetation (Rujescu 2010). Throughout the research period, the states of growing the seedlings were different from one surface to the other side, depending on the station (Stanciu & Tabără-Amânar 2008). Considering all five species in

2010, which saw the highest rainfall is observed that seedlings of *A. pseudoplatanus, E. angustifolia* presented the best condition of vegetation, while seedlings of *P. abies* and *P. sylvestris* showed the weakest state of vegetation.

Table 2

Gaps filling made inside the work perimeters in 2010

No. of the afforestation perimeter	*The area covered for completions (ha)*	*The afforestation composition*	*No. of seedlings, of which:*		
			Total	*Principal species*	*Secondary species*
S_1 – u.a. 2E	0.7	6PIN2SL2PAM	3.500	2800	700
S_2 – u.a. 4D	0.02	6PIN2SL2PAM	100	80	20
S_3 – u.a. 4E	0.02	6PIN2SL2PAM	100	80	20
S_4 - u.a. 4F	0.2	6PIN2SL2PAM	1.000	800	200
S_5 – u.a. 5C	0.25	6PIN2SL2PAM	1.250	1.000	250
S_6 - u.a. 5G	0.03	6MO2PIN2SC	150	150	-
S_7 – u.a. 8D	2.70	6MO2PIN2SC	13.500	13.500	-
S_8 – u.a. 8E	0.06	6MO2PIN2SC	300	300	-
S_9 – u.a. 9D	0.1	6MO2PIN2SC	500	500	-
S_{10} – u.a. 25D	0.6	6MO2PIN2SC	3.000	3.000	-
Total	4.68		23.400	22.210	1.190

Table 3

Gaps filling made inside the work perimeters in 2011

No. of the afforestation perimeter	*The area covered for completions (ha)*	*The afforestation composition*	*No. of seedlings, of which:*		
			Total	*Principal species*	*Secondary species*
S_1 – u.a. 2E	0.5	6PIN2SL2PAM	2.500	2.000	500
S_2 – u.a. 4D	0.02	6PIN2SL2PAM	100	80	20
S_3 – u.a. 4E	0.02	6PIN2SL2PAM	100	80	20
S_4 - u.a. 4F	0.02	6PIN2SL2PAM	100	80	20
S_5 – u.a. 5C	0.03	6PIN2SL2PAM	150	120	30
S_6 - u.a. 5G	0.02	6MO2PIN2SC	100	100	-
S_7 – u.a. 8D	2.00	6MO2PIN2SC	10.000	10.000	-
S_8 – u.a. 8E	0.06	6MO2PIN2SC	300	300	-
S_9 – u.a. 9D	0.1	6MO2PIN2SC	500	500	-
S_{10} – u.a. 25D	0.5	6MO2PIN2SC	2.500	2.500	-
Total	3.27		16.350	15.760	590

Table 4

Seedlings vegetative state according to their annual growth

Vegetative stage	*Pinus sylvestris*	*Eleagnus angustifolia*	*Acer pseudoplatanus*	*Picea abies*	*Robinia pseudacacia*
Lanced	3-4 cm	15-20 cm	10-15 cm	3-3.5 cm	15-20 cm
Normal	4.5-5 cm	20.5-25 cm	15.5-18 cm	3.5-4 cm	20.5-25 cm
Good	5.5-6 cm	25.5-30 cm	18.5-25 cm	4.5-5 cm	25.5-30 cm
Very good	6.5-9 cm	30.5-40 cm	25.5-30 cm	5.5-6 cm	30.5-40 cm

Looking at the overall condition of vegetation seedlings of the species studied, it was observed in 2011, a superior behavior of *E. angustifolia* seedlings and *A. pseudoplatanus*, while *P. abies* achieved the lowest annual increases. Considering all five species, it appears that in 2012 *E. angustifolia* seedlings and *A. pseudoplatanus* showed the best condition of vegetation, while seedlings of *P. abies* and *P. sylvestris* showed the weakest state of vegetation (Laţo 2012; Abrudan et al 2009).

Research areas are in number 10 and are numbered with Arabic numerals. Research areas are located on three types of State (4410 - mountain-piedmont of beech, edaphic rendzinic middle overshadowed 4420 - mountain-piedmont of beech, brown

edaphic middle shaded dental Asperula, 4421 - mountain-piedmont of beech, partly sunny Asperula dental); Three forest types (4117 – Beech mountain soils skeletons lower productivity, 4114 - Beech mountain flora mull medium productivity; 2212 – *Abies alba - Fagus sylvatica* productivity mull flora middle) and three soil types (soil unevolved and Cambisols: typical brown soils).

In Table 5, we consider all five species in 2010, which saw the highest rainfall is observed that seedlings of *A. pseudoplatanus* and *E. angustifolia* presented the best condition of vegetation, while seedlings of *P. abies* and *P. sylvestris* showed the weakest state of vegetation.

Table 5

The vegetation stage of seedling in 2010

Species	*u.a.*	*The vegetation status of seedlings (%)*			
		Lanced	*Normal*	*Good*	*Very good*
Pinus sylvestris	S1	20	60	20	0
	S2	20	70	10	0
	S3	30	60	10	0
	S4	40	50	10	0
	S5	40	50	10	0
$\bar{x} \pm s_{\bar{x}}$		30.00±4.47	58.00±3.74	12±2.00	0
Eleagnus angustifolia	S1	0	0	100	0
	S2	0	0	100	0
	S3	10	0	90	0
	S4	10	0	90	0
	S5	0	0	100	0
$\bar{x} \pm s_{\bar{x}}$		4.00±2.45	0	96.00±2.45	0
Acer pseudoplatanus	S1	10	0	90	0
	S2	10	0	90	0
	S3	10	0	90	0
	S4	0	0	100	0
	S5	20	0	80	0
$\bar{x} \pm s_{\bar{x}}$		10.00±3.16	0	90.00±3.16	0
Picea abies	S6	70	30	0	0
	S7	50	50	0	0
	S8	60	40	0	0
	S9	50	50	0	0
	S10	40	60	0	0
$\bar{x} \pm s_{\bar{x}}$		54.00±5.10	46.00±5.10	0	0
Robinia pseudacacia	S6	10	0	60	30
	S7	0	0	90	10
	S8	10	0	70	20
	S9	0	0	70	30
	S10	0	0	60	40
$\bar{x} \pm s_{\bar{x}}$		4.00±2.45	0	70.00±5.48	26.00±5.10

In the climatic conditions of 2011, seedlings of *P. sylvestris* showed generally good condition vegetation (42%) and normal (36%), while 22% have achieved lower annual increases, with a state of vegetation lanced (Table 6). Without registering differences between research areas in terms of vegetation status, it appears that the surfaces S4 and S5 were identified most seedlings which achieved annual growth of 5.5 -6 cm (Ciolac et al 2013a; Smejkal et al 1995).

From the point of view of the state of vegetation in 2011, *E. angustifolia* seedlings were grouped into two categories, namely: 52% with good vegetation condition and 48% in very good condition. Stationary conditions had little influence on the state of vegetation *E. angustifolia* seedlings in 2011 (Chisăliţă et al 2010).

Table 6

The vegetation stage of seedling in 2011

Species	u.a.	The vegetation status of seedlings (%)			
		Lanced	Normal	Good	Very good
Pinus sylvestris	S1	20	40	40	0
	S2	20	50	30	0
	S3	30	30	40	0
	S4	20	30	50	0
	S5	20	30	50	0
$\bar{x} \pm s_{\bar{x}}$		22.00±2.00	36.00±4.00	42.00±3.74	0
Eleagnus angustifolia	S1	0	0	60	40
	S2	0	0	50	50
	S3	0	0	50	50
	S4	0	0	50	50
	S5	0	0	50	50
$\bar{x} \pm s_{\bar{x}}$		0	0	52.00±2.00	48.00±2.00
Acer pseudoplatanus	S1	0	0	40	60
	S2	0	0	60	40
	S3	0	0	70	30
	S4	0	0	40	60
	S5	10	0	70	20
$\bar{x} \pm s_{\bar{x}}$		2.00±2.00	0	56.00±6.78	42.00±8.00
Picea abies	S6	80	20	0	0
	S7	60	40	0	0
	S8	80	20	0	0
	S9	80	20	0	0
	S10	50	50	0	0
$\bar{x} \pm s_{\bar{x}}$		70.00±6.32	30.00±6.32	0	0
Robinia pseudacacia	S6	10	0	60	30
	S7	0	0	70	30
	S8	10	0	70	20
	S9	0	0	50	50
	S10	0	0	60	40
$\bar{x} \pm s_{\bar{x}}$		4.00±2.45	0	62.00±3.74	34.00±5.10

Concerning *A. pseudoplatanus* species, it appears that the seedlings received the most favorable conditions for vegetation in research areas S1 and S4, where 60% of the seedlings had a very good state of vegetation. The lowest annual increases, i.e. a state of vegetation weaker seedlings of *A. pseudoplatanus* has been registered into the S5, where only 20% of seedlings had a very good state of vegetation.

In *P. abies*, most seedlings (70%) presented in 2011 a state of vegetation lanced, and 30% had a normal state. Less favorable growing conditions for this species were observed in the areas of research S6, S8 and S9, where 80% of the seedlings growing condition manifesting a lanced (Ciulcă 2006).

R. pseudacacia seedlings had in 2011 annual increases of good (62%) or very good (34%), while 4% of them had very low annual growth. Good and very good vegetative conditions associated with the highest annual increases were recorded in areas S9 and S10.

Looking at the overall condition of vegetation seedlings of the species studied, we observed in 2011 a superior behavior of *E. angustifolia* and *A. pseudoplatanus* seedlings, while *P. abies* achieved the lowest annual increases (Banu et al 2013).

Given the data presented in Table 6, due to the stationary conditions, were inventoried most seedlings of *P. sylvestris* with a very good state of vegetation. In general, the type of resort had no major influence on the state of vegetation seedlings of this species (Bordean et al 2010).

The stationary conditions of the surfaces S2 and S3 were found higher frequencies of seedlings with a lanced vegetation condition associated with reduced frequency of seedlings with a very good state of vegetation. Overall, 68% of seedlings of *P. sylvestris*

had a good growing season, 20% good condition, 10% and 2% state lanced a normal state (Abrudan 2006).

Most *E. angustifolia* seedlings (62%) showed good vegetative condition, while the other showed a very good (30%) and 8% a normal state of vegetation. S4 research area showed the highest frequency of seedlings with a very good growing season, registering annual growth of 30.5 to 40 cm height.

In the S5 research area, 80% of *E. angustifolia* seedlings achieved annual growth of 25.5 to 30 cm, thus showing a good growing season. In the research areas S1, S2 and S3, which have the same stationary conditions, there was a high uniformity of the distribution of seedlings in terms of the state of vegetation.

In the case of *A. pseudoplatanus*, stationary conditions had little influence on the state of vegetation, mostly grouped in two classes, with 64% very good and 30% good condition. Thus, it appears that three research areas (S1, S2 and S4) inventoried seedlings showed a similar distribution, with 70% very good and 30% good condition. The research area S3 saplings were identified and lanced a state of vegetation (Table 7).

Table 7

The vegetation stage of seedling in 2012

Species	*u.a.*	*The vegetation status of seedlings (%)*			
		Lanced	*Normal*	*Good*	*Very good*
Pinus sylvestris	S1	10	0	70	20
	S2	20	0	70	10
	S3	10	10	70	10
	S4	10	0	60	30
	S5	0	0	70	30
$\bar{x} \pm s_{\bar{x}}$		10.00±3.16	2.00±2.00	68.00±2.00	20.00±4.47
Eleagnus angustifolia	S1	0	10	60	30
	S2	0	10	60	30
	S3	0	10	60	30
	S4	0	10	50	40
	S5	0	0	80	20
$\bar{x} \pm s_{\bar{x}}$		0	8.00±2.00	62.00±4.90	30.00±3.16
Acer pseudoplatanus	S1	0	0	70	30
	S2	0	0	70	30
	S3	10	0	60	30
	S4	0	0	70	30
	S5	0	20	50	30
$\bar{x} \pm s_{\bar{x}}$		2.00±2.00	4.00±4.00	64.00±4.00	30.00±0.00
Picea abies	S6	70	30	0	0
	S7	60	40	0	0
	S8	60	40	0	0
	S9	70	30	0	0
	S10	50	50	0	0
$\bar{x} \pm s_{\bar{x}}$		62.00±3.74	38.00±3.74	0	0
Robinia pseudacacia	S6	0	10	70	20
	S7	0	10	50	40
	S8	10	0	60	30
	S9	0	0	80	20
	S10	0	0	50	50
$\bar{x} \pm s_{\bar{x}}$		2.00±2.00	4.00±2.45	62.00±5.83	32.00±5.83

The seedlings of *P. sylvestris* are generally present in a lanced status (62%) and normal (28%) of the growing season. The most vigorous specimens were inventoried in the research area S10, while S6 and S9 research areas were identified seedlings with the lowest annual increases (Figures 1 and 2).

Figure 1. Research surface S1 wooded with 6PIN2SL2PAM on sterile dumps. Photo in the forest field after afforestation (after 1 year).

Figure 2. Research S1 area forested with the composition 6PIN2SL2PAM in 2 years after the onset of vegetation. Photo in the forest field after afforestation (after 2 years).

R. pseudacacia seedlings showed good and very good vegetative condition, recording annual increases of 25.5 to 30 cm high (62%) and annual increases of 30.5 to 40 cm (32%). The seedlings from S10 research area received the most favorable growing conditions (Martin et al 2013).

Considering all five species, it appears that in 2012 *E. angustifolia* and *A. pseudoplatanus* seedlings showed the best condition of vegetation, while seedlings of *P. abies* and *P. sylvestris* showed the weakest state of vegetation (Curec (Bacău) et al 2012; Ciolac et al 2013b).

Research surfaces placed near the area of ground brown soils typically 60-70% of *Pinus sylvestris* seedlings showed a normal vegetation condition, lanced 20-30% and 10-20% in good condition. In research surfaces placed near the brown soil zone eumezobazic rezicalcaric, general vegetation seedlings of this species was weaker. Thus, only 50% of them showed a normal condition, lanced 40% state and 10% good condition.

Results of afforestation with *P. sylvestris* upper soils are brown soils typical brown soils to soils rezicalcarice.

If *E. angustifolia* seedlings, stationary conditions or forest type and state had less influence on the state of vegetation compared to *P. sylvestris*. Thus, it appears that three research areas (2E, 4D and 5C), all inventoried seedlings showed good vegetative state, while surfaces 4E and 4F has also been a 10% seedlings with state lanced. On average, 96% of seedlings of this species showed a very good growing condition and only 4% were state lanced.

Most seedlings of *A. pseudoplatanus* (90%) showed good vegetative condition, while the rest showed a lanced state. If 4F areas, seedlings of this species have received the most favorable growing conditions, so that all people had a good, recording annual increases from 18.5 to 25 cm height. 5C surface, 20% of seedlings of *A. pseudoplatanus* achieved annual growth of 10-15 cm, showing such a state of lower vegetation.

Seedlings of *P. abies* showed a weaker vegetative state, registering annual growth of 3-3.5 cm low (54%) and the remainder (46%) annual increases of 3.5-4 cm. For areas located around the area with soil typical brown soils, a vegetation status seedling was weaker than the surface soil around the area eumenobazic rezicalcaric.

Acacia seedlings showed generally good state of the vegetation (70%) and very good (26%). The most vigorous specimens were inventoried in unit 25 D, while the surface 8E and seedlings were identified with a state of vegetation lanced (10%). For this species, in 2010, it was observed that the type of forest and resort did not have a major influence on the state of vegetation seedlings.

As the influence of climatic conditions on the state of seedlings of *P. sylvestris* vegetation, it appears that this species has received the most favorable conditions in 2012, so 20% of the seedlings had a very good state and 68% had a good state vegetation. The climatic conditions in 2010, characterized by a lower contribution of rainfall in the first six months, seedlings of this species had the lowest annual increases. Thus, 30% of seedlings showed a lanced state, 58% normal state and only 12% of them had a good growing season.

On the state of vegetation *E. angustifolia* seedlings during the experimental period, we find that in 2010 due to higher values of average temperatures showed the highest frequency of seedlings with a very good growing season. In 2011, 48% of seedlings of this species have achieved average growth of 30.5 to 40 cm, while in 2012, the frequency of these seedlings was lower (30%).

Seedlings of *A. pseudoplatanus* showed the best condition of vegetation in 2011, when 42% of them achieved average growth of 25.5 to 30 cm, while in 2012 these increases were recorded for 30% of seedlings. In 2010, most seedlings (90%) showed a good growing season, but the bottom other years.

Due to the influence of climatic conditions on the vegetation status of *P. abies* seedlings, it appears that this species has benefited from similar conditions on vegetation throughout the experimental period. Seedlings were distributed into two classes, namely 54-70% showed a 30-46% state lanced and vegetation normal state. Increases most intense it was observed in 2010, and the lowest in 2011.

On the state of vegetation *R. pseudacacia* seedlings during the experimental period, we find that in 2011 recorded the highest frequency (34%) of seedlings with a very good growing season. In 2010, only 26% of seedlings of this species have achieved average growth of 30.5 cm - 40 cm. As such, the influence of climatic conditions on vegetation condition *R. pseudacacia* seedlings was reduced.

Both species and climatic conditions during 2009-2012 research or species interaction stationary conditions had considerable influence, statistically the manifestation of the height growth of seedlings at the five species included in the study. Of these sources of variation, special effects were predominantly (72.28%), followed by climatic conditions (17.25%), while the interaction of these two factors contributed 10.48% to the variability of growth seedlings.

Seedlings of *A. pseudoplatanus* have used more efficiently climatic conditions of the experimental period, registering increases very significant annual growth rate compared to other species with values in the study. *E. angustifolia* and *R. pseudacacia*

seedlings have used equally growing conditions during this period, achieving similar values of growth. It also notes that coniferous species showed significantly lower values and lower growth rate compared to hardwood.

Conclusions. Regarding afforestation compositions in the study it is observed that formula afforestation with *P. sylvestris*, *E. angustifolia* and *A. pseudoplatanus* showed a very significant percentage higher grip and an increase of 11% compared to formula afforestation with *P. abies*, *P. sylvestris* and *R. pseudacacia*. The afforestation scheme with *P. sylvestris, A. pseudoplatanus* and *E. angustigolia* was strongly influenced by climate variability.

Both species and climatic conditions during the research or species interaction with stationary conditions had significant influence, were statistically the event of height growth of seedlings from five species included in the study. Of these sources of variation, the effect was mainly species (72.28%), followed by climatic conditions (17.25%), while the interaction of these two factors contributed 10.48% growth rate variability of seedlings.

Stationary conditions of the experimental period and distinct species have a real influence on the increase in diameter significant contribution to the variability of climatic conditions seedlings of this character is predominant (65.51%), while species contributes 9.30%. Also the interaction of species with a stationary conditions had a distinct influence on the growth significant 25.19% in diameter studied species.

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Authors:
Ramona Lile, "Aurel Vlaicu" University from Arad, Faculty of Economic Sciences, B-dul Revoluţiei 77, 310130 Arad, Romania, e-mail: ramonalile@yahoo.com
Sorin Stanciu, Banat University of Agricultural Science and Veterinary Medicine Timişoara, Faculty of Farm Management, Calea Aradului 119, 300645 Timişoara, Romania, e-mail: sorinmstanciu@yahoo.com
Simona Martin, Banat University of Agricultural Science and Veterinary Medicine Timişoara, Faculty of Farm Management, Calea Aradului 119, 300645 Timişoara, Romania, e-mail: simi_con@yahoo.it
Mihaela Moatar, Banat University of Agricultural Science and Veterinary Medicine Timişoara, Faculty of Horticulture and Forestry, Calea Aradului 119, 300645 Timişoara, Romania, e-mail: mihaelamoatar@yahoo.com

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