THE USE OF *PINUS NIGRA* L. FOR ARRANGING ERODED SLOPES

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Abstract. Vegetation, as soil protection factor, has a positive influence during the process of land degradation through both canopy that retains some of the water and through the root system that functions as a drain. The main objective of this study is to observe how Pinus nigra trees growing arranged degraded slopes. The observations and determinations regarding biometric characteristics conducted in this study were: total height; trunk thickness at soil level; trunk thickness above 1 m from soil level; trunk thickness above 1.5 m from soil level.

Keywords: trunk thickness, tree height, ground level

INTRODUCTION

Soil erosion is a natural process t, which is exacerbated by human activities. Most actual concerns about soil erosion refer to accelerated erosion, where the natural rate has been increased significantly by human activities (Lal, 2006; Osman, 2014; Giandon, 2015).

Erosion occurs with great intensity on slopes and sandy soils and is mostly due to the destruction of the herbaceous vegetation and of the forest. Irrational deforestation was and is still causing the most serious consequences because the forest has always been a natural balance of precipitation (Parichi, 2007; Ozer *et al.,* 1998; Patha *et al*., 1997; Poesen *et al.,* 1993).

Pinus nigra is one of the most important silvicultural species in central and Southern Europe (CABI, 2013). *P. nigra* is the main species used in reforestation. As a hardy and pioneer species, it is used for reforestation in mountain zones, including those in difficult soil conditions (Burdon, 2002).

MATERIAL AND METHOD

On Pinus nigra trees were made observations regarding biometric characteristics as follows: total height (m) – denoted with "y"; trunk thickness at soil level (cm) –denoted with "x_1"; trunk thickness above 1 m from soil level (cm) – denoted with "x_2"; trunk thickness above 1.5 m from soil level (cm) – denoted with "x_3". The role of these measurements is to observe the effects of Cluj-Napoca City climate on the development of pine trees on the slope. The pine trees were planted with approximately 14 years ago. The biometric determinations were carried out on 51 trees located in the north-west of Cluj-Napoca City. The results of measuring the trunk at ground level thickness (cm) are between 6.5 cm - the minimum limit of variation and 48.1 cm – the maximum limit of variation, with an average ($\bar{x}_{x_1}$) of 26.00 cm. The line width data of the trunk measured at 1 m from the ground has a minimum limit of variation of 3.0 cm and a maximum limit of variation of 30.0 cm, and the average value is ($\bar{x}_{x_2}$) = 18.17 cm.

a.   b.

Figure 1. General aspects from experimental field – Cluj-Napoca City
Source:a. Google Earth b. Original

The average thickness of the trunk measured at 1.5 m from the ground ($\bar{x}_{x_3}$) is 14.52 cm, showing evidence of a minimum of variation of 2.1 cm and a maximum of 33.4 cm. The average of the total heights of the 51 individuals of measured pines is 2.95 m, and is noted with $\bar{x}_y$. The lower height limit registered is 0.864m, and the higher limit is 5.098 m. The results are presented as histograms, and for frequency have settled a number of 8 classes according ARDELEAN (2008), there are over 51 measurements for each biometric character.

RESULTS AND DISCUSSION

As it can be noticed from the Figure 2 of the series of measurements on 51 black pine trees, it was found a total of 16 values for class whose center is 19.5 cm and 13 values for class center 24.7 cm. On the other hand, one can notice that in the sample as there were very few individuals who had a thick trunk (less than 16.9 cm, with a relative frequency of 5.88%) and very high (over 37.7 cm with a relative frequency of 9.80%) determined to the ground. In relative terms, the specimens with thickness at ground level had a rate of 80.31% between 16.9 cm and 32.5 cm.

As it can be noticed from the Figure 3 of measurements series that it was found a total of 18 values for class whose center is 14.8 cm, and 9 values for class center 18.2cm. On the other hand, it can be seen that there is an inequality between the sample thickness 1 m from the trunk at ground level, thus 6 values of 28.3 cm for middle class and middle class 3 values to 4.7 cm. In relative terms, the specimens with trunk thickness at ground level had a rate of 68.63% between 13.1 cm and 19.9 cm.

As it can be noticed from the Figure 4 of the series of measurements on 51 black pine trees, it found a total of 16 values for class whose center is 11.9 cm and 12 values for class center with 15.8cm. On the other hand, it can be seen that there is evidence inequality between individuals who have demonstrated a trunk thickness (less than 9.9 cm, with a relative frequency of 5.88%) and very high (over 31.7 cm with a relative frequency of 9.80%) determined at the level 1.5 m above ground level. In relative terms, the specimens with trunk thickness at 1.5 m above ground level presented at a rate of 54,90% between 9.9 cm and 13.8 cm.

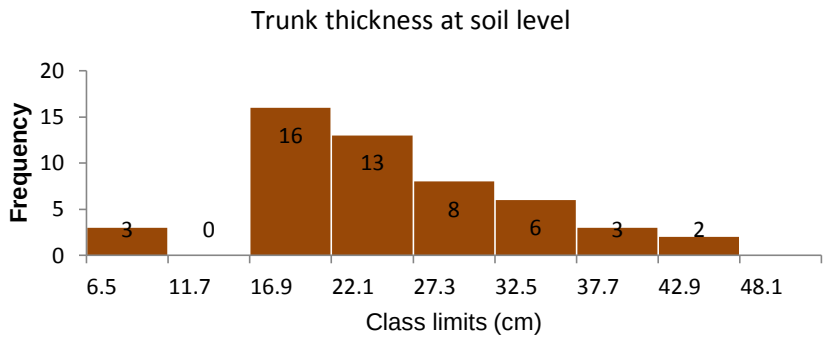

Fig. 2. Frequency histogram after trunk thickness at soil level – fir tree, Cluj-Napoca (Cluj County)

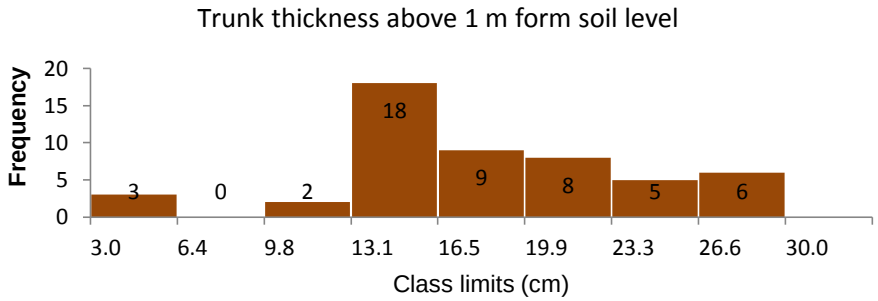

Fig. 3. Frequency histogram after trunk thickness above 1 m from soil level, Cluj-Napoca (Cluj County)

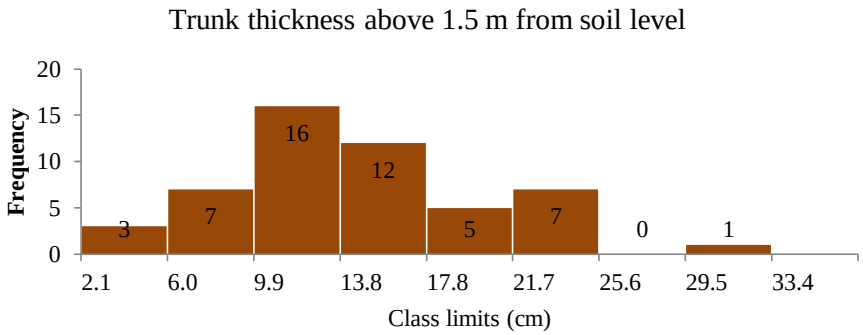

Fig. 4. Frequency histogram after trunk thickness above 1,5 m from soil level, Cluj-Napoca (Cluj County)

Can be seen from the Figure 5 series of measurements on 51 black pine trees, it found a total of 14 values for class whose center is 3.246 m and 13 values of 2.716 m class center. On the other hand, it can be seen that there is an evident inequality between individuals who have demonstrated a low height (under 2.187 m with a relative frequency of 11.76%) and very high (over 4.304 m, with a relative frequency 9.80%). In relative terms, the specimens which were made on the overall height measurements were 64.71% in the proportion of this nature between 1.923 and 3.510 m.

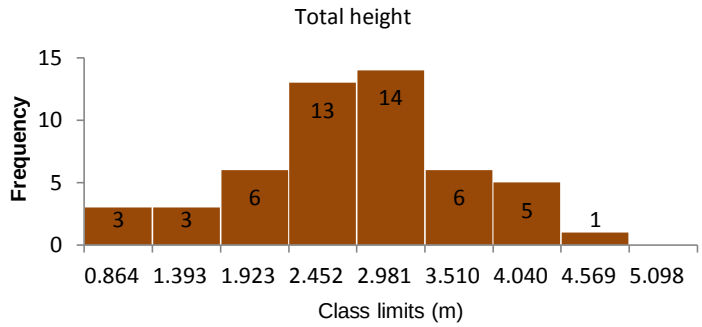

Fig. 5. Frequency histogram after total height, Cluj-Napoca (Cluj County)

According to the scale of assessment given by ARDELEAN (2008), it can be said that the 4 rows of measurements on individuals Pine blacks installed on the slope, showed high variability at all four characters determined, with coefficient of variation is s% > 30% (Table 1).

Table 1

Dispersion indices of measurements conducted on fir tree – Cluj-Napoca (Cluj County)

Character / Dispersion indices	Trunk thickness (cm)			Height (m)
	At soil level	Above from soil level		
		1 m	1.5 m	
Total tree samples (n)	51	51	51	51
Sum of the determined character ($\sum x$)	1325.900	926.770	740.300	150.351
Mean ($\bar{x}$)	26.00	18.17	14.52	2.95
Correction (C)	34470.800	16841.228	10745.963	443.244
Sum of squared individual values (SP)	38065.530	18668.245	12629.770	483.016
Sum of squared mean deviations (SPA)	3594.730	1827.017	1883.807	39.773
Free degree (GL)	50	50	50	50
Variance (s^2)	71.89	36.54	37.68	0.80
Standard deviation (s)	8.48	6.04	6.14	0.89
Variability coefficient (s%)	32.61	33.26	42.29	30.25

Calculated from data variance (s^2) and standard deviation (s), and other data presented in the table above were calculated and the standard deviation of the mean ($s_{\bar{x}}$) for each character in part, as follows:

- $s_{\bar{x}}$ = 1.19 cm – for determinations trunk thickness at soil level
- $s_{\bar{x}}$ = 0.85 cm – for determination trunk thickness above 1 m from soil level;
- $s_{\bar{x}}$ = 0.86 cm – for determinations trunk thickness above 1.5 m from soil level;
- $s_{\bar{x}}$ = 0.12 m – for determinations total height to trees of *Pinus nigra*.

By using distributions empirical and theoretical - Distribution "t" to set the confidence interval of the mean of each series of measurements, accruing to one standard deviation, confidence intervals averaging as following:

$\bar{x}_{x_1} = 26{,}00 \text{ cm} \pm 1{,}19 \text{ cm}$ - trunk thickness at soil level;

$\bar{x}_{x_2} = 18{,}17 \text{ cm} \pm 0{,}85 \text{ cm}$ - trunk thickness above 1 m from soil level;

$\bar{x}_{x_3} = 14{,}52 \text{ cm} \pm 0{,}86 \text{ cm}$ - trunk thickness above 1,5 m from soil level;

$\bar{x}_y = 2{,}95\ \text{m} \pm 0{,}12\ \text{m}$ – Total height .

The table 2 presents values that define real confidence interval for the mean of 51 measurements on black pine trees, the four biometric characters.

Table 2

Real confidence intervals – fir tree, Cluj-Napoca (Cluj County)

Theoretic standard deviations	Trunk thickness (cm)			Height (m)
	At soil level	Above from soil level		
		1 m	1,5 m	
$P_{5\%} = 2.01$	26.00 cm ± 2.39 cm	18.17 cm ±1.70 cm	14.52 cm ±1.73 cm	2.95 m ± 0.25 m
$P_{1\%} = 2.68$	26.00 cm ± 3.18 cm	18.17 cm ± 2.27 cm	14.52 cm ±2.30 cm	2.95 m ± 0.33 m
$P_{0,1\%} = 3.49$	26.00 cm ± 4.14 cm	18.17 cm ± 2.95 cm	14.52 cm ± 3.00 cm	2.95 m ± 0.44 m

CONCLUSIONS

In the sample there were very few individuals who had a thick trunk, driven to the ground, less vigorous (16.9 cm below with a relative frequency of 5.88%) and very vigorous (over 37.7 cm with a relative frequency of 9.80%). In the sample there is a tie between trunk thickness 1 m from ground level such extremes recorded call 6 with middle class values of 28.3 cm (most robust) and 3 for middle-class values 4.7 cm (the least developed class). In sample there was a tie between individuals who had a thick trunk, determined at 1.5 m from the ground, as follows: force low (below 9.9 cm, with a relative frequency of 5.88%) and very (greater than 31.7 cm, with a relative frequency of 9.80%).

In sample there was a tie between individuals who have demonstrated a low height (under 2.187 m with a relative frequency of 11.76%) and very high (over 4.304 m, with a relative frequency of 9.80%).

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