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THE VARIABILITY STUDY OF MORPHOLOGICAL CHARACTERS ON SOME *SALIX SPP.* GENOTYPES

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keywords: energy willow, genotypes, location, genetic variability, ecological conditions.

ABSTRACT

The present study followed the analysis of some characters of 14 Romanian and Swedish genotypes of energy willow in different ecological conditions. Thus, they were analyzed the next characters: stem diameter on the base, total grow/pl., grow/stem, plant height and. no. of stems/pl. The analyzed factors were: the area and the genotype. The area factors had three levels: Radovan (medium fertility soil - Control), Târnăveşti (sandy soil on irrigation) and Ișalnița (antropomorphic soil formed from coal ash). The recorded date showes the diversity and the genetic potential of the biological material, emphesizing the well beahivour of the local genotypes RO 1077, RO 1082 and RO 892 created on ICAS Bucharest in the three location. The foreign genotypes with good results were Inger si Torhild. Analyzing the averagre values recored in the three location, the best results were obtained in the Tamburesti area under irrigation conditions, no matter the studied character, the humidity level from the soil being a key factor for the success of the energy willow crop, no matter the soil type or genotype.

INTRODUCTION

Worldwide, according to the latest research in the field, there are concerns about the use of biomass for energy purposes. Rapid growth trees in short-lived crops are able to produce high yields over short periods. Since the 1980s, willow have become recognized as biomass crops (Karp, 2015).

In-depth knowledge of biological systems has contributed to the development of the biotechnological revolution. Its main purpose is to solve some stringent problems at the global level, especially in the field of agriculture, energy and environmental protection (Bonciu Elena, 2014).

Biomass willow crops increase the diversity of experimental habitats in poor agricultural areas for annual plants and not in areas of forest holdings. These crops can exploit on the sloping land, fix the soil and improve its quality, and can play the role of bioremediation of polluted soils by extracting excess ions and can be used to exploit heavily polluted soils such as tailings dumps, ash, soils, eroded soils, sand etc.

In Romania, SRC-type crops have been developed in 2005, exclusively on non-agricultural and non-forest land. Inger is the most cultivated Swedish commercial clone in Romania (Hernea et al., 2015, 2016), but experimental studies have been conducted with other Swedish and Romanian clones.

The advantages of using SRC willow for biomass production include rapid growth and high biomass production, regeneration capacity after multiple crops, ease of vegetative propagation from latent woody cuttings. The willow crops of SRC is considered a sustainable source of biomass because of its potential to fix carbon (C) in the soil. Short-term crops are an option for solving the demand for bioenergy. But slopes are also important for the phytoremediation of degraded lands because of salicylic acid content (Hernea et al., 2016).

MATERIAL AND METHOD

This study analyzed the variability of some characters from 14 Romanian and Swedish energy willow genotypes in different ecological conditions. Thus, there were analyzed the next characters: stem diameter on the base; total grow/plant; grow/stem; plant height and no. of stems/pl.

The analyzed factors were: the ecological area and the genotype. The area factors had three levels: Radovan (medium fertility soil - Control), Tâmburești (sandy soil on irrigation) and Ișalnița (antropomorphic soil formed from coal ash).

Concerning the humidity level, all three areas are in the same range, the weather date collected from Craiova Weather Station being relevant for them. Thus, in year 2017 the rainfall from spring and summer didn't surpass 161 mm. If in the spring months those cumulated 87 mm, in June, July, August and September there were recorded a total of 19 mm. The only exception was in July, when there were recorded 55 mm cumulated in 48 hours. In Tâmurești area the crops were under irrigation conditions during this period.

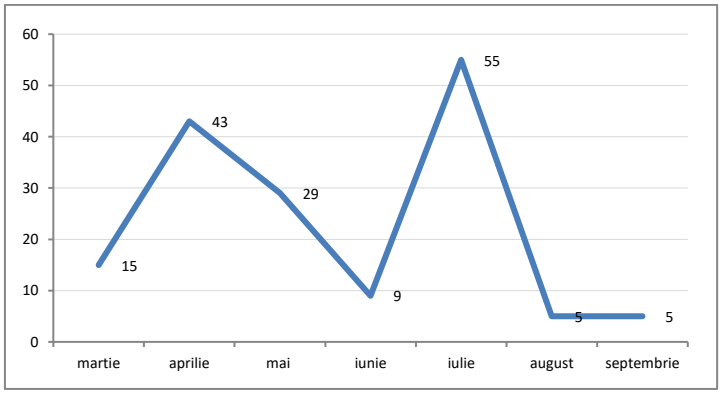


Chart 1- The rainfall recorded during March-September 2017, on Craiova Weather Station

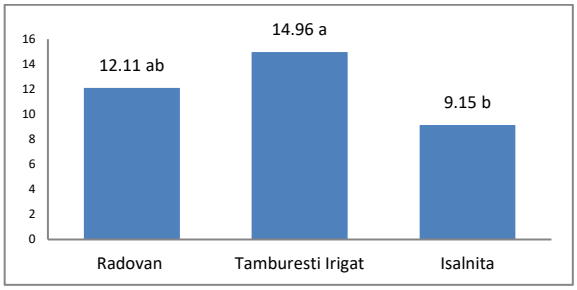
The Romanian genotypes were: RO 892, RO 1077, RO 1082, Cozia, Fragisal, Pesred and Robisal. The Swedish genotypes were: Torhild, Sven, Inger, Olof, Jorr, Tora and Tordis.

From statistical point of view, there were studied: the influence of the are factor over each character; the influence of the genotype over each character and the factors interaction over each character. The significance of the differences between samples was established using the LSD, calculated for p=0.05.

RESULTS AND DISSCUSIONS

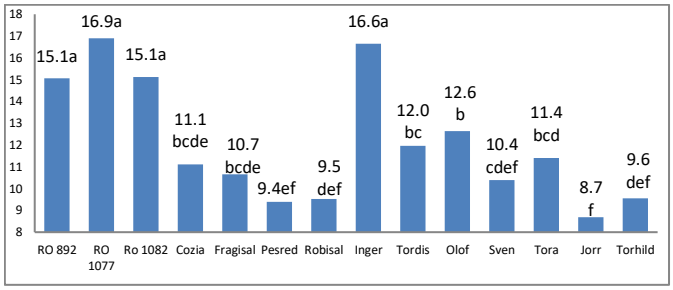
On the stem diameter on the base analysis for each location, the highest value was recorded in Tâmburești area with an average of 14.96 mm fallowed by the value recorded in the Radovan area (12.11 mm). Between values recorded in Tâmburești and Radovan area, there were no statistical difference, the only statistical difference being recorded between value recorded in Tâmburești and value recorded in Ișalnița (5.8 mm) (Chart 2).

Concerning the influence of the genotype for this character, the best result was recorded on the RO1077 genotype, with a value of 16.9 mm, followed by Inger genotype. There are no statistical differences between first four genotypes, those ones being statistical different from the rest. The last one, Jorr genotype, is statistical different from the first nine ranked genotypes (Chart 3).



LSD 5%=4.02 mm

Chart 2-The variation analysis of the stem diameter on the base character according to location (mm)



LSD 5%=1.91 mm

Chart 3-The variation analysis of the stem diameter on the base character according to genotype (mm)

In the case of comparative analysis of genotypes by location, statistical differences were found between values by locations. For all genotypes, the best result was obtained on the Tâmbureşti area location, the second was obtained at the Radovan area, all genotypes having the lowest values in the Ișalnita area.

Table 1

The variation analysis of the stem diameter on the base character according to location and genotype (mm)

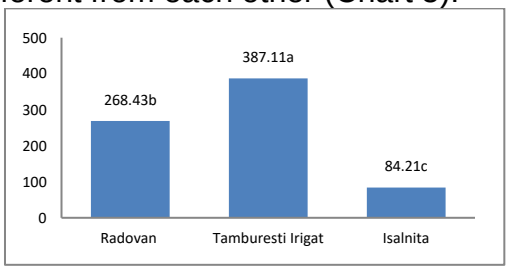
RO			SWE		
Genotype	Area	stem diameter on the base	Genotype	Area	stem diameter on the base
RO 892	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	15.88ab 16.64a 12.64c	Inger	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	17.15b 20.68a 12.11c
RO 1077	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	18.53a 19.17a 13.00b	Tordis	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	11.52b 15.26a 9.11b
RO 1082	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	14.99b 18.38a 12.00b	Olof	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	12.47b 16.34a 9.12c
Cozia	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	10.80b 14.28a 8.28b	Sven	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	10.80a 13.23a 7.15b
Fragisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	10.40ab 13.30a 8.26b	Tora	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	10.10b 14.31a 9.80b
Pesred	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	9.11ab 11.79a 7.26b	Jorr	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	9.91a 9.98a 6.15b
Robisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	8.11b 14.32a 6.13b	Torhild	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	9.79ab 11.77a 7.11b
Average	12.54		11.61		
LSD 5% = 3.32 mm					

Statistically speaking, in the case of three genotypes (RO1077, Sven and Jorr), the first two values are significantly different from the third rank, in the case of 8 genotypes (RO1082, Cozia, Fragisal, Pesred, Robisal, Tordis, Tora and Torhild), the first value is significantly differentiated from the other two, while for three genotypes (RO892, Inger and Olof) all three values differ significantly between them (Table 1).

On the grow/stem character analysis for each location, the highest value was recorded in Tâmbureşti area with an average of 387.11 cm fallowed by the value recorded in the Radovan area (268.43 cm). From statistical point of view, all three values are statically differentiated between them (Chart 4).

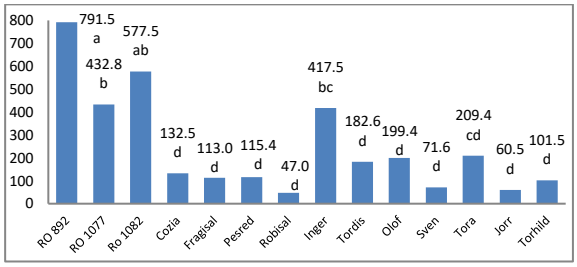
Concerning the influence of the genotype for this character, the best result was recorded on the RO892 genotype, with a value of 791.5 cm, followed by RO1082 genotype. From a statistical point of view, the RO892 genotype differs from all other, without

differentiating from the second one. The last 10 classified genotypes are not statistically different from each other (Chart 5).



LSD 5% = 43.78 cm

Chart 4 - The variation analysis of grow/stem character according to location (cm)



LSD 5% = 215.86 cm

Chart 5 - The variation analysis of grow/stem character according to genotype (cm)

In the case of comparative analysis of genotypes by location, for 8 genotypes there are no statistically differences between variants. For 5 genotypes the first classified value was recorded in the Tâmburești area (Table 2).

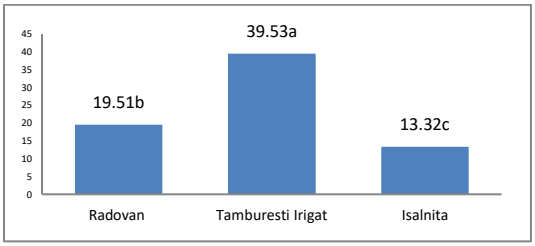
Table 2

The variation analysis of grow/stem character according to location and genotype (cm)

RO			SWE		
Genotype	Area	Grow/stem	Genotype	Area	Grow/stem
RO 892	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	1631.70a 492.75b 250.00b	Inger	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	365.38b 763.13a 124.00b
RO 1077	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	428.32ns 570.21ns 300.00ns	Tordis	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	101.75ab 423.10a 23.00b
RO 1082	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	414.01b 1068.38a 250.00b	Olof	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	117.21ab 453.95a 27.00b
Cozia	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	111.00ns 211.46ns 75.00ns	Sven	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	40.25ns 162.63ns 12.00ns
Fragisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	105.00ns 208.95ns 25.00ns	Tora	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	115.88b 500.28a 12.00b
Pesred	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	125.00ns 199.21ns 22.00ns	Jorr	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	72.08ns 88.33ns 21.00ns
Robisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	50.00 ns 76.00 ns 15.00 ns	Torhild	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	80.46ns 201.18ns 23.00ns
Average	315.67		177.50		
LSD 5% = 373.87 cm					

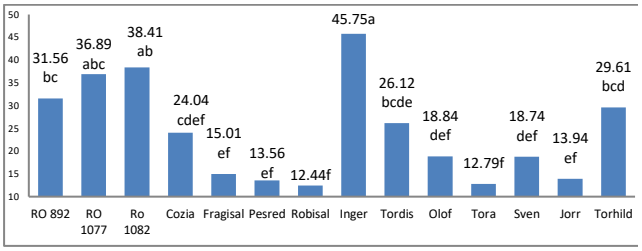
In the case of total grow/pl. character, the highest value was recorded in the Târnpureşti area with a value of 39.53 cm, the second place being the value recorded in the Radovan area (19.51 cm), the last quantified value being in the Șalnița area (13.32 cm), statistically, the three recorded values differing significantly between them (Chart 6).

On comparative analysis of genotypes, the best result was recorded by the Inger genotype, with a value of 45.75 cm, followed by the RO1082 genotype. From the statistical point of view, the first three genotypes are distinguished from all other genotypes but are not differentiated between them. The last eight classified genotypes are not different from each other (Chart7).



LSD 5% = 2.56 cm

Chart 6 - The variation analysis of total grow/pl. character according to location (cm)



LSD 5% =12.62 cm

Chart 7 - The variation analysis of total grow/pl. character according to genotype (cm)

On the analysis of genotypes by location, there were identified 8 statistical differences between locations. For all genotypes, the highest value was obtained at the Tâmbureşti location, the second one being obtained at the Radovan location, all the genotypes having the lowest values in the Isalniţa location (Table 3).

Table 3

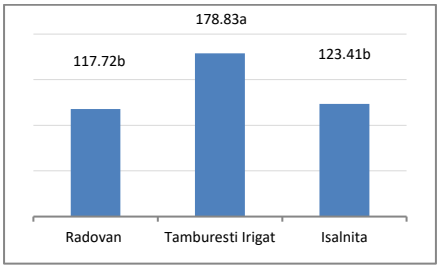
The variation analysis of total grow/pl. character according to location and genotype (cm)

RO			SWE		
Genotype	Area	total grow/pl.	Genotype	Area	total grow/pl.
RO 892	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	26.88b 56.11a 11.70c	Inger	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	38.79b 78.25a 20.22b
RO 1077	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	30.17b 62.11a 18.40b	Tordis	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	18.13b 42.11a 18.12b
RO 1082	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	34.75b 60.25a 20.22c	Olof	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	14.11ns 30.27ns 12.14ns
Cozia	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	20.11b 42.12a 9.89c	Sven	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	8.45ns 20.12ns 9.80ns
Fragisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	11.48ab 28.14a 5.40b	Tora	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	13.45ns 28.27ns 14.50ns
Pesred	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	12.11ns 22.11ns 6.47ns	Jorr	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	12.46ns 20.22ns 9.14ns
Robisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	9.78ns 18.27ns 9.28ns	Torhild	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	22.48b 45.12a 21.22b
Average	24.56		23.68		
LSD 5% = 21.86 cm					

Concerning the total height character according to the location, the highest value was recorded in the area of Tâmbureşti with a value of 178.83 cm, the second place being the value recorded in the Radovan area (123.41 cm), the last value (117.72 cm) (Chart 8).

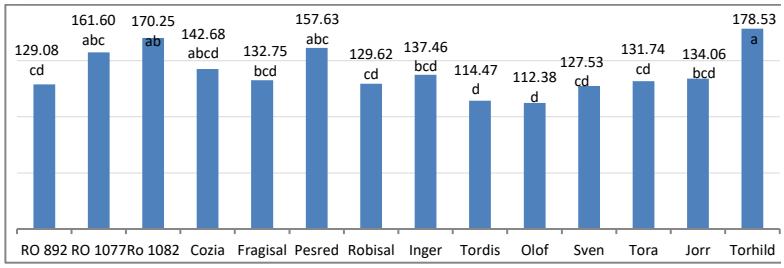
The smaller increase in the Isalnita area is due to the installation of the drought and the reduced water retention capacity of ash, so the willow finds favorable growth conditions only during the first part of the vegetation period (Soare, M., 2017).

In the case of comparative analysis of genotypes, the best result was recorded by the genotype Torhild, with a value of 178.53 cm, followed by the genotype RO1082. Note that the last nine genotypes are not statistically different from each other, while the first ranked genotype does not statistically differ from the following four (Chart 9).



LSD 5% = 7.75 cm

Chart 8 - The variation analysis of the plant height character according to location (cm)



LSD 5% =38.21 cm

Chart 9 - The variation analysis of the plant height character according to genotype (cm)

In the case of comparative analysis of genotypes by location, statistically significant differences were recorded in 6 of the genotypes studied. In the case of these, the highest values were registered in the Tâmbureşti area, with the second position being recorded in the Radovan area (Table 4).

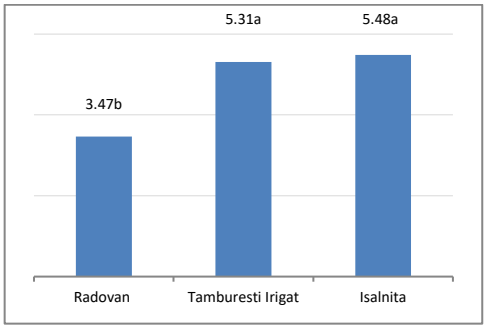
Table 4

The variation analysis of the plant height character according to location and genotype (cm)

RO			SWE		
Genotype	Area	Height	Genotype	Area	Height
RO 892	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	131.3ns 148.874ns 107.06ns	Inger	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	82.82b 230.28a 99.283b
RO 1077	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	121.2ns 185.032ns 166.6ns	Tordis	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	88.88ns 141.4ns 113.12ns
RO 1082	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	166.65ab 205.737a 138.37b	Olof	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	112.514ns 136.35ns 88.274ns
Cozia	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	158.57ns 147.965ns 121.503ns	Sven	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	124.634ab 163.62a 94.334b
Fragisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	97.263ns 142.41ns 158.57ns	Tora	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	78.073b 200.99a 116.15b
Pesred	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	133.32b 203.01a 148.47ab	Jorr	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	88.88b 198.97a 114.332b
Robisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	93.93b 171.7a 123.22ab	Torhild	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	169.983ab 227.25a 138.37b
Average	146.23		133.74		
LSD 5% = 66.18 cm					

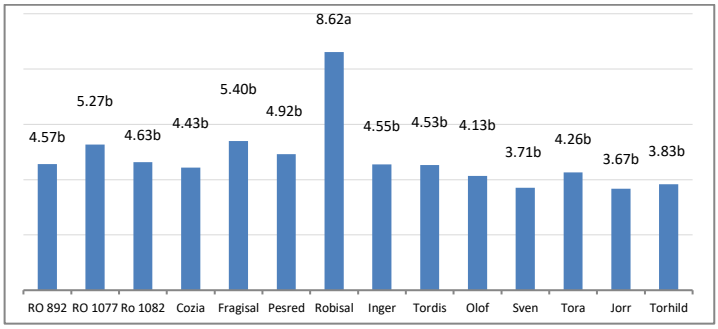
On the analysis of no. of stems/pl. according to the location, the highest value was recorded in the Ișalnita area with a value of 5.48 stems/pl., the second place being the value recorded in the Tâmpureşi area (5.31 stems/pl.), the last quantified being the one in the Radovan area (3.47 stems/pl.) (Chart 10).

In the comparative analysis of genotypes, the best result was recorded by the Robisal, with a value of 8.62 stems/pl., which is significantly from all other genotypes. Excepting the first one, there were no statistically significant differences between the other studied genotypes (Chart 11).



LSD 5% = 1.15 stems/pl.

Chart 10 - The variation analysis of the no. of stems/pl. character according to location (cm)



LSD 5% = 2.41 stems/pl.

Chart 11 - The variation analysis of the no. of stems/pl. character according to genotype (cm)

In the case of comparative analysis of genotypes by location, there were identified 11 statistical differences between locations. For all genotypes, the best result was obtained on the Işalniţa location, the second obtained on the Tâmbureşti location, all genotypes having the lowest values in the Radovan location (Table 5). It seems that this indicator records higher values on lighter soils, under the conditions of Radovan, the variation amplitude being lower for the no. of stems/pl. (Soare, M. 2016)

Table 5

The variation analysis of the no. of stems/pl. character according to location and genotype (cm)

RO			SWE		
Genotype	Area	no. of stems/pl.	Genotype	Area	no. of stems/pl.
RO 892	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	3.7ns 5.4ns 4.6ns	Inger	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	3.24ns 4.8ns 5.6ns
RO 1077	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	4.1ns 6.4ns 5.3ns	Tordis	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	4.5ns 5.7ns 3.4ns
RO 1082	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	4.6ns 5.8ns 3.5ns	Olof	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	2.9ns 4.2ns 5.3ns
Cozia	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	3.2ns 4.2ns 5.9ns	Sven	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	2.83ns 4.1ns 4.2ns
Fragisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	3.1b 6.8a 6.3a	Tora	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	2.89b 5.2a 4.7a
Pesred	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	5.1ns 5ns 4.66ns	Jorr	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	3.1ns 3.4ns 4.5ns
Robisal	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	2.65c 9.2b 14a	Torhild	RADOVAN (Mt.) TÂMBUREȘTI IȘALNIȚA	2.6ns 4.1ns 4.8ns
Average	5.41		4.10		
LSD 5% =3.12 stems/pl.					

CONCLUSIONS

Regarding the statistical analysis of the stem diameter on the base, the best result is obtained in the area of Tâmbureşti, these having a significant difference compared to the average recorded in the area of Işalnita. There are also statistical differences between genotypes, regardless of location.

In the case of the analysis of the total grow/pl., the average value obtained in the Tâmbuşti area is significantly different from the average recorded in the Radovan and Isalniţa areas, those last ones being statistically different. In case of comparative analysis of genotypes by location, for the vast majority of genotypes, the best result was obtained on the Tâmureşti area, the second obtained at the Radovan site, all the genotypes having the lowest values at the Isalniţa site.

Plant height analysis highlights the results obtained in the Tâmureşti area, which is significantly different from the average recorded in the Radovan and Isalniţa areas. In the case of comparative analysis of genotypes, the best result was recorded by the Torhild genotype, with a value of 178.53 cm, followed by the genotype RO1082. Regarding the comparative analysis of genotypes by location, statistically significant differences were recorded on five of the genotypes: Torhild, Pesred, Cozia, RO 1077 and RO 1082.

Related to no. of stems/pl. depending on the location, the best result is obtained on the Isalnita location. In the case of comparative analysis of genotypes by location, statistical differences between locations for 11 genotypes were identified. Of all the genotypes in the three locations, the best result was obtained by the Robisal genotype, followed by Fragisal and RO 1077.

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