MULTIPLE COMPARISONS BETWEEN SOME FODDER BEET GENOTYPES BASED ON LEAF MORPHOLOGICAL CHARACTERS

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Abstract: *In animal feeding are used both the roots and the leaves of the fodder beets. Because the leaves have an important role in photosynthesis, the present work focused on the study of the leaf morphological characters of 16 fodder beet genotypes grown in Timisoara, during 2002-2010. The data used in the paper are collected along five years, because in the second year was obtained the seed. The fodder beet is characterized as a plant with indeterminate growth and it is strongly influenced by the agro-ecological conditions. The development of the leaf and root morphological characters of the fodder beets are strongly influenced by light intensity, temperature, precipitations and soil nutrient. (LUMINITA COJOCARIU AND MOISUC A., 2005; ALBAYRAK S. AND NECDET Ç., 2007). As any fodder crops, the fodder beets have the same natural needs. The number of leaves has a large variability and it is very much influenced by genetic factors and also by environmental ones. To emphasize the degree of externalization of the leaf characters, its have been used 16 fodder beet genotypes of different origins, which have been seeded with own seed. The goals of this paper is to perform multiple comparisons between the Angoba, Monro, Brigadier, Gonda, Ketil, Tamara, Marshal, Kyros I, Fumona, Beta Rosa, Troya, Feldher, Polifuraj 2, Tamon, Zentaur and Ursus genotypes of fodder beets based on the leaf morphological characters (namely foliar surface, leaf weight and leaf number). We used the the Bonferroni's test to determine the statistical differences between the above genotype. The mean, the minimum, the maximum, the lower quartile, the upper quartile, the variance, the standard deviation, the skewness and the kurtosis for the foliar surface, for the leaf weight and for the leaf number respectively of the above genotypes of fodder beets were pointed out. The pairwise comparisons between the studied genotypes using the Bonferroni's test allow us to conclude that in general, there are statistically significant differences between the studied genotypes from the point of view of foliar surfaces, the leaf weights and leaf number, but we also found out the genotypes which are not statistically different.*

Key words: *fodder beets, leaf morphological characters, multiple comparisons test, Bonferroni's test*

INTRODUCTION

Since the XVIIIth century, the fodder beet represented an important part of the succulent fodders, with high digestibility, consumed by bovine in winter in the west-European countries (LENKENS, 1990; LAUWERS T., et al, 2009). In the bovine food rations, the fodder beet can partially replace the concentrates, because of its high concentration of energy (OTTO et al, 1994). The roots of fodder beet can be kept over six months in silos, without lose their quality. Beet leaves can be administrated in animals fresh or these can be ensilaged together with other fodders.

The fodder beet has a great photosynthetic capacity which, cumulated with the long vegetation period, makes its yields per hectare to be some of the largest. The leaves represent 20-25% of root weight and have a role in photosynthesis. Low light intensity and high temperatures lead to an increase of the foliar surface an of SLA index in the varieties Ecdogelb and Ecdorot, studied by ALBAYRAK S. and NECDET Ç. (2007).

Green leaf number presents a high variability in the fodder beet, being very much influenced by the genetic factors and by environmental factors too.

MATERIAL AND METHODS

The experiments have been prepared in Timisoara during the years 2002-2010, each variety being consecutively cultivated for five years. The area is located in the West Plain of Romania. After Koppen, the climate of the mentioned perimeter is framed into the climatic province c.f.b.x., being a temperate climate, with precipitation all over the year, excepting the summer months when is recorded a deficit. The soil where the experiments were developed is a low gleyed cambic chernozem.

The biological material that was studied is represented by 16 varieties of fodder beet belonging to the monogerm and plurigerm forms of fodder beet, with different origins, cultivated and studied for five years in the collection campus of the Didactic and Experimental Station of U.S.A.M.V.B Timisoara. In the second and next years, there was used for sowing the seeds obtained in our field of seed production. The seeding was realised in plots, at 50 cm distance between rows and 20 cm distance between the plants of the same row. The observations and the biological measurements were made for a number of 25 plants.

The sowing was done on 5/3m parcels, at a distance of 50 cm between rows and 20 cm between plants per row, ensuring 150 harvested plants on every parcel. It was used the Latin square design with 3 repetitions. The evaluation of the leaf morphological characters (foliar surface, leaf weight and leaf number) has been done by biometric measurements of 25 plants from every parcel and repetition respectively. The foliar surface was measured with the Digital Placom planimeter.

Statistical analyses have been performed by STATISTICA 8 package (PETERSEN R.G., 1994; MEAD R. et aL., 2002, LUMINIȚA COJOCARIU and V.D. LALESCU, 2010).

Familywise error (FWE), also known as alpha inflation or cumulative Type I error, represents the probability that any one of a set of comparisons or significance tests is a Type I error. One can estimate familywise error with the following formula $\alpha_{FWE} \leq 1-(1-\alpha_{EC})^{c}$, where α_{FWE} is the familywise error rate, α_{EC} is the alpha rate for an individual test (almost always considered to be .05), and c is the number of comparisons. The Bonferroni test calculates a new pairwise alpha $\alpha_{B} = \frac{\alpha_{FWE}}{c}$ to keep the familywise alpha value at .05 (or another specified value).

RESULTS AND DISCUSSIONS

The basic descriptive statistics for the leaf foliar surfaces were shown in the Figure 1. It can be remarked that the average foliar surface of the leafs was 3379,51 cm^2, the minimum foliar surfaces was 2116,2 cm^2 obtained at Ketil genotype, the maximum foliar surfaces was 4899,54 cm^2 obtained for Zentaur genotype. The variance and the standard deviation were 482491,04 and 694,61 respectively. There were 3 genotypes with the foliar surfaces between 2000-2500 cm^2, 11 genotypes with the foliar surfaces between 2500-3000 cm^2, 20 genotypes with the foliar surfaces between 3000-3500 cm2, 5 genotypes with the foliar surfaces between 3500-4000 cm^2, 3 genotypes with the foliar surfaces between 4000-4500 cm^2, 6 genotypes with the foliar surfaces between 4500-5000 cm2. The lower and upper quartiles were 2934,73 and 3694,76 respectively. The repartition of the data around the normal distribution was tested with Kolmogorov-Smironov test showing that the data are normally distributed around the mean. The skewness and kurtosis were 0,68 and -0,12 respectively.

It was performed a Bonferoni test in the analysis of variance for the leaf foliar surfaces in order to find the statistical differences between the studied genotypes (see Table 1).

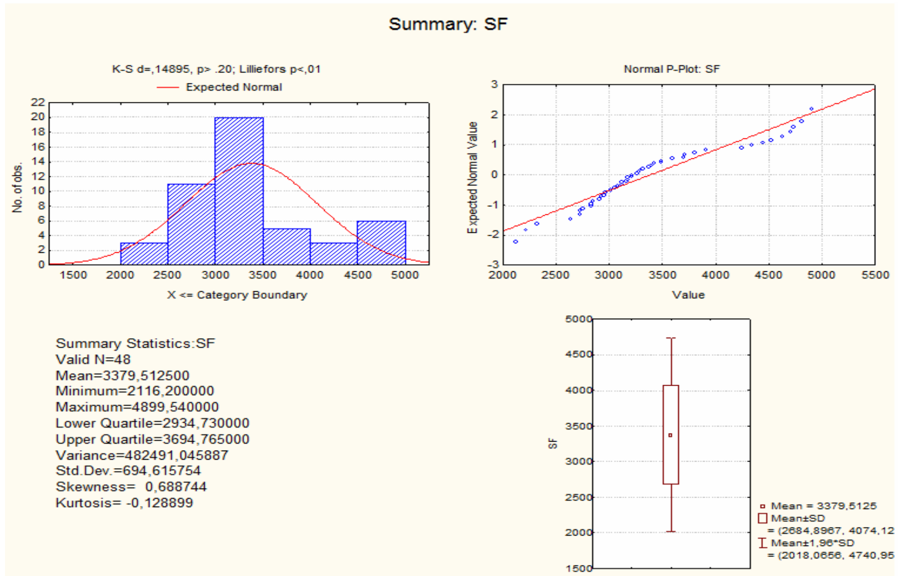

Figure 1: Basic descriptive statistics for the leaf foliar surfaces

It can be concluded that in general, there are statistically significant differences between the studied genotypes, but it have also been found that there are no statistical differences between Angoba and Beta Rosa, Troya, Feldher, Polifuraj 2, Ursus; between Monro and Brigadier, Tamara, Kyros I, Beta Rosa, Polifuraj 2, Ursus; between Gonda and Marshal, Kyros I; between Kyros I and Polifuraj 2; between Fumona and Tamon, Zentaur; between Beta Rosa and Troya, Feldher, Polifuraj 2, Ursus.

Table 1

Bonferroni's test for the leaf foliar surfaces

Bonferroni test; foliar surfaces; Probabilities for Post Hoc Tests

Genotypes	{1} 2845,2	{2} 3170,7	{3} 3310,4	{4} 3587,2	{5} 2216,2	{6} 3263,8	{7} 3802,4	{8} 3385,7	{9} 4622,8	{10} 3010,7	{11} 2824,3	{12} 2728,4	{13} 3110,8	{14} 4339,5	{15} 4799,5	{16} 3054,7
Angoba		0,043	0,000	0,000	0,000	0,001	0,000	0,000	0,000	1,000	1,000	1,000	0,323	0,000	0,000	1,000
Monro			1,00	0,001	0,000	1,000	0,000	1,000	0,000	1,000	0,021	0,000	1,000	0,000	0,000	1,000
Brigadier				0,224	0,000	1,000	0,000	1,000	0,000	0,105	0,000	0,000	1,000	0,000	0,000	0,444
Gonda					0,000	0,047	1,000	1,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Ketil						0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Tamara							0,000	1,000	0,000	0,481	0,000	0,000	1,000	0,000	0,000	1,000
Marshal								0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Kyros I									0,000	0,007	0,000	0,000	0,238	0,000	0,000	0,036
Fumona										0,000	0,000	0,000	0,000	0,181	1,000	0,000
BetaRosa											1,000	0,187	1,000	0,000	0,000	1,000
Troya												1,000	0,162	0,000	0,000	0,976
Feldher													0,005	0,000	0,000	0,042
Polifuraj2														0,000	0,000	1,000
Tamon															0,000	0,000
Zentaur																0,000
Ursus																

The basic descriptive statistics for the leaf weights were shown in the Figure 2. It can be observed that the average leaf weight was 135,2g, the minimum leaf weight was 78,66g obtained at the Troya genotype, and the maximum leaf weight was 185,28g obtained for the Brigadier genotype. The variance and the standard deviation were 859,70 and 29,32 respectively. There was 1 genotype with the leaf weight between 60-80g, 3 genotypes with the leaf weight between 80-100g, 14 genotypes with the leaf weight between 100-120g, 6 genotypes with the leaf weight between 120-140g, 12 genotypes with the leaf weight between 140-160g, 10 genotypes with the leaf weight between 160-180g, 2 genotypes with the leaf weight between 180-200g. The lower and upper quartiles were 108,54 and 161 respectively. The repartition of the data around the normal distribution was tested with Kolmogorov-Smironov test showing that the data are normally distributed around the mean. The skewness and kurtosis were -0,03 and -1,16 respectively.

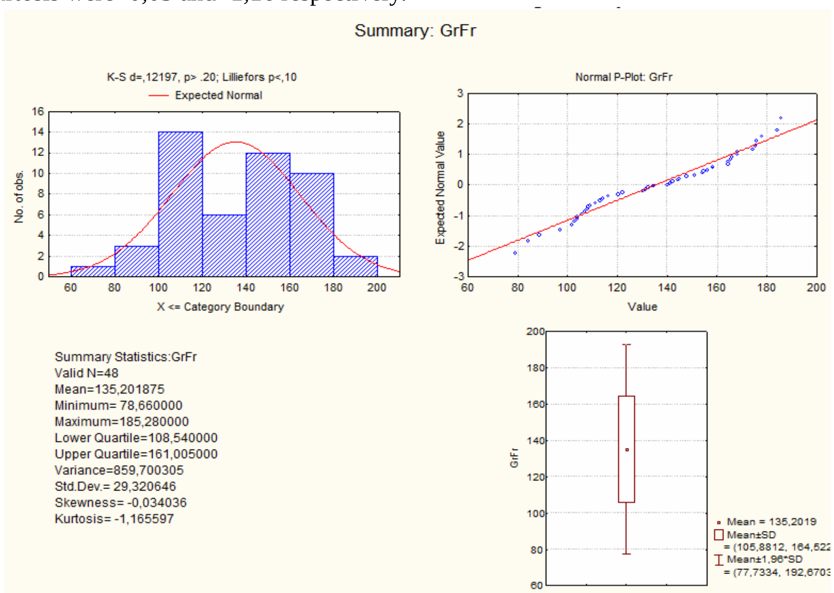

Figure 2: Basic descriptive statistics for the leaf weights

Table 2

Bonferroni's test for the leaf weights

Bonferroni test; leaf weights; Probabilities for Post Hoc Tests

Genotypes	{1} 167,95	{2} 101,66	{3} 175,28	{4} 130,05	{5} 157,78	{6} 108,33	{7} 107,77	{8} 174,22	{9} 131,86	{10} 140,89	{11} 83,660	{12} 110,83	{13} 144,44	{14} 108,75	{15} 154,06	{16} 165,70
Angoba		0,000	1,000	0,000	1,000	0,000	0,000	1,000	0,001	0,054	0,000	0,000	0,220	0,000	1,000	1,000
Monro			0,000	0,031	0,000	1,000	1,000	0,000	0,015	0,000	1,000	1,000	0,000	1,000	0,000	0,000
Brigadier				0,000	1,000	0,000	0,000	1,000	0,000	0,002	0,000	0,000	0,011	0,000	0,526	1,000
Gonda					0,041	0,437	0,353	0,000	1,000	1,000	0,000	1,000	1,000	0,511	0,181	0,001
Ketil						0,000	0,000	1,000	0,085	1,000	0,000	0,000	1,000	0,000	1,000	1,000
Tamara							1,000	0,000	0,219	0,005	0,140	1,000	0,001	1,000	0,000	0,000
Marshal								0,000	0,176	0,004	0,174	1,000	0,001	1,000	0,000	0,000
Kyros I									0,000	0,004	0,000	0,000	0,017	0,000	0,778	1,000
Fumona										1,000	0,000	0,565	1,000	0,257	0,364	0,003
BetaRosa											0,000	0,015	1,000	0,006	1,000	0,132
Troya												0,051	0,000	0,119	0,000	0,000
Feldher													0,003	1,000	0,000	0,000
Polifuraj2														0,001	1,000	0,519
Tamon															0,000	0,000
Zentaur																1,000
Ursus																

It was performed a Bonferoni test in the analysis of variance for the leaf weights in order to find the statistical differences between the studied genotypes (see Table 2). It can be concluded that in general, there are statistically significant differences between the studied genotypes, but it have also been found that there are no statistical differences between Angoba and Brigadier, Ketil, Kyros I, Beta Rosa, Polifuraj 2, Zentaur, Ursus; between Monro and Tamara, Marshal, Troya, Feldher, Tamon; between Brigadier and Ketil, Kyros I, Zentaur, Ursus; between Gonda and Tamara, Marshal, Fumona, Beta Rosa, Feldher, Polifuraj 2, Tamon, Zentaur; between Ketil and Fumona, Fumona, Beta Rosa, Polifuraj 2, Zentaur, Ursus.

The basic descriptive statistics for the average leaf numbers were shown in the Figure 3. It can be seen that the average leaf number was 20,62, the minimum leaf numbers was 13,99 obtained at the Monro genotype, the maximum leaf numbers was 26,55 obtained for the Brigadier genotype. The variance and the standard deviation were 10,98 and 3,31 respectively. There was 1 genotype with the leaf numbers between 12 and 14, 2 genotypes with the leaf numbers between 14 and 16, 10 genotypes with the leaf numbers between 16 and 18, 8 genotypes with the leaf numbers between 18 and 20, 10 genotypes with the leaf numbers between 20 and 22, 8 genotypes with the leaf numbers between 22 and 24, 7 genotypes with the leaf numbers between 24 and 26, 2 genotypes with the leaf numbers between 26 and 28. The lower and upper quartiles were 17,87 and 23,33 respectively. The repartition of the data around the normal distribution was tested with Kolmogorov-Smironov test showing that the data are normally distributed around the mean. The skewness and kurtosis were -0,02 and -0,76 respectively.

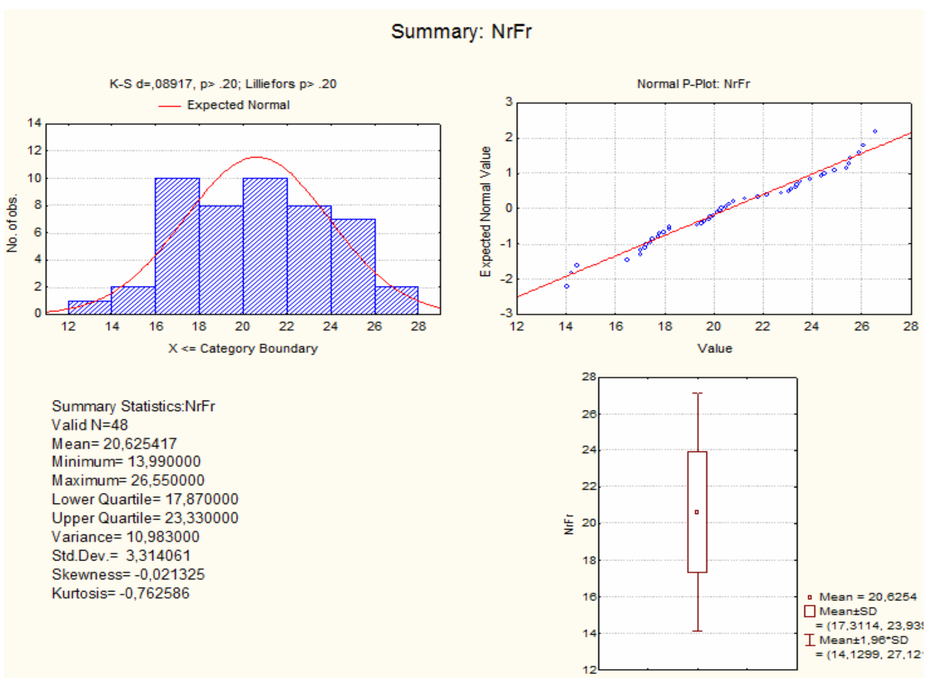

Figure 3: Basic descriptive statistics for the leaf numbers

It was performed a Bonferoni test in the analysis of variance for the leaf numbers in order to find the statistical differences between the studied genotypes (see Table 3). It can be concluded that in general, there are statistically significant differences between the studied genotypes, but it have also been found that there are no statistical differences between Angoba, Tamara, Marshal, Beta Rosa, Feldher, Polifuraj 2, Ursus; between Brigadier, Troya, Zentaur;

between Gonda, Ketil, Kyros I, Fumona, Troya, Zentaur; between Ketil, Marshal, Kyros I, Polifuraj 2, Tamon, Ursus.

Table 3

Bonferroni's test for the leaf numbers

Bonferroni test; leaf number; Probabilities for Post Hoc Tests

Genotypes	{1} 17,9	{2} 14,1	{3} 26,0	{4} 23,0	{5} 21,2	{6} 17,2	{7} 19,9	{8} 21,7	{9} 24,3	{10} 17,0	{11} 24,8	{12} 17,6	{13} 20,1	{14} 20,2	{15} 24,5	{16} 19,8
Angoba		0,000	0,000	0,000	0,000	1,000	0,139	0,000	0,000	1,000	0,000	1,000	0,070	0,034	0,000	0,285
Monro			0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000
Brigadier				0,000	0,000	0,000	0,000	0,000	0,600	0,000	1,000	0,000	0,000	0,000	1,000	0,000
Gonda					0,455	0,000	0,000	1,000	1,000	0,000	0,272	0,000	0,001	0,003	1,000	0,000
Ketil						0,000	1,000	1,000	0,000	0,000	0,000	0,000	1,000	1,000	0,000	1,000
Tamara							0,003	0,000	0,000	1,000	0,000	1,000	0,001	0,000	0,000	0,006
Marshal								0,350	0,000	0,001	0,000	0,033	1,000	1,000	0,000	1,000
Kyros I									0,007	0,000	0,000	0,000	0,668	1,000	0,003	0,171
Fumona										0,000	1,000	0,000	0,000	0,000	1,000	0,000
BetaRosa											0,000	1,000	0,000	0,000	0,000	0,002
Troya												0,000	0,000	0,000	1,000	0,000
Feldher													0,016	0,007	0,000	0,070
Polifuraj2														1,000	0,000	1,000
Tamon															0,000	1,000
Zentaur																0,000
Ursus																

CONCLUSIONS

This article starts with the basic descriptive statistics (mean, minimum, maximum, lower quartile, upper quartile, variance, standard deviation, skewness, kurtosis) for the leaf morphological characters (foliar surface, leaf weight and leaf number) of the Angoba, Monro, Brigadier, Gonda, Ketil, Tamara, Marshal, Kyros I, Fumona, Beta Rosa, Troya, Feldher, Polifuraj 2, Tamon, Zentaur and Ursus genotypes of fodder beets. Then it was performed pairwise comparisons between the above genotypes using the Bonferroni's test and it can be concluded that in generally, there are statistically significant differences between the studied genotypes from the point of view of foliar surfaces, the leaf weights and leaf number, but we also found out that:

- from the point of view of the foliar surfaces, there are no statistical differences between Angoba and Beta Rosa, Troya, Feldher, Polifuraj 2, Ursus; between Monro and Brigadier, Tamara, Kyros I, Beta Rosa, Polifuraj 2, Ursus; between Gonda and Marshal, Kyros I; between Kyros I and Polifuraj 2; between Fumona and Tamon, Zentaur; between Beta Rosa and Troya, Feldher, Polifuraj 2, Ursus;

- from the point of view of the leaf weights, there are no statistical differences between Angoba and Brigadier, Ketil, Kyros I, Beta Rosa, Polifuraj 2, Zentaur, Ursus; between Monro and Tamara, Marshal, Troya, Feldher, Tamon; between Brigadier and Ketil, Kyros I, Zentaur, Ursus; between Gonda and Tamara, Marshal, Fumona, Beta Rosa, Feldher, Polifuraj 2, Tamon, Zentaur; between Ketil and Fumona, Fumona, Beta Rosa, Polifuraj 2, Zentaur, Ursus;

- from the point of view of the leaf numbers, there are no statistical differences between Angoba, Tamara, Marshal, Beta Rosa, Feldher, Polifuraj 2, Ursus; between Brigadier, Troya, Zentaur; between Gonda, Ketil, Kyros I, Fumona, Troya, Zentaur; between Ketil, Marshal, Kyros I, Polifuraj 2, Tamon, Ursus.

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