PAIRWISE COMPARISONS BETWEEN SOME FODDER BEET GENOTYPES IN THE CONDITIONS OF TIMISOARA

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Abstract

Fodder beets (Beta vulgaris L. var. crassa Mansf.) are grown at present in almost all European countries and in Romania on large areas in the West Plains, where the climatic and soil conditions favour its growth. The fodder beet, which is used both the root and the leaves, is renowned as one of the richest sources of energy in animal feeding. It offers higher yield potential than any other forage crop.

The average root yields under favourable conditions may exceed 100 t.ha^{-1} (Rzekanowski C. and colab., 2005, Moisuc Al.., and colab., 2003), and the leaves could contribute to the overall production with another 10-15t.ha^{-1}. The roots are administered in chopped form in the winter while the leaves can be used fresh or ensiled with other feed (Albayrak S. and Necdet Ç., 2006;, Luminița Cojocariu and Moisuc Al., 2005).

Fodder beet is characterized as a plant with indeterminate growth; it is strongly influenced by agro-ecological conditions. The foliar and the root development are strongly influenced by light intensity, the temperature, the precipitation and the content of soil nutrients. (Albayrak S. and Necdet Ç., 2007; Moisuc Al. and colab., 2004; Luminița Cojocariu and Moisuc Al., 2005).

The problems related to variability of fodder beet characters, require the study of the genotype behaviours on some production characters depending on the conditions of western Romania. Reliable information on their production value allows us to use them as selection criteria in a comparative study. The studied biological materials are represented by 14 varieties of fodder beet, of different origins, which were seeded with the own seed obtained in Timisoara, in the period 2006-2010.

The goals of this paper is to perform multiple comparisons between the Brigadier, Gonda, Zentaur, Belmono, Jamon, Magnus, Vauriac, Barbara, Colosse, Kyros, Taune, Feldherr, Polifuraj 2, Ursus Poly genotypes of fodder beets based on the production characters (namely root weight, leaf weight and plant weight). We used the the Scheffe'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 root weight, for the leaf weight and for the plant weight respectively of the above genotypes of fodder beets were pointed out. The pairwise comparisons between the studied genotypes using the Scheffe's test allow us to conclude that in general, there are statistically significant differences between the studied genotypes from the point of view of the root weight, the leaf weight and the plant weight, but we also found out the genotypes which are not statistically different.

Keywords: fodder beets, root weight, leaf weight, plant weight, multiple comparisons test, Scheffe's test.

INTRODUCTION

Fodder beet feed (*Beta vulgaris* L. var. *crassa Mansf.*) is considered to be very valuable (Van Waes and colab., 2007). The fodder beet root contains a small amount of dry matter (DM), around 15%, a small quantity of fiber (5% of DM) (De Vliegher and colab., 2006), proteins (9-16% of DM) (Aerts J. and colab., 1979,), minerals (calcium, phosphorus and magnesium) and rich in carbohydrates (50-70% of DM) (De Vliegher and colab., 2006). The fodder beet is an energo-proteic feed consumed by animals in the winter. (Otto and colab., 1994; Meijer and colab., 1994).

The main production characters of fodder beet are greatly influenced by environmental conditions and nutrient regime. The root and leaf weight increase by the manure application, by nitrogen fertilizers and by the application of foliar biostimulators (Luminiţa Cojocariu and Moisuc Al., 2005). The green leaf weight is another important and practical character because, with root weight, determine the biological production of fodder beet.

Experiments carried out in Croatia by Štafa, Zvonimir and colab. (1988), to some fodder beet genotypes showed significant differences between varieties with respect to production characters. The largest variation of leaves and roots weights were found at Eckendorf genotype.

MATERIAL AND METHOD

The experiments have been prepared in Timisoara during the years 2006-2010, 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 evolution of climatic resources within the period 2006-2010 distinguishes their oscillatory character, with notable deviations from the multi-annual mean value (see table 1,2).

Table 1

The monthly mean temperatures (°C) registered at Meteorological Station of Timişoara (2006-2010)

Specification	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2006	-2.0	0.00	5.0	12.4	16.2	19.5	23.6	20.1	17.5	12.5		
2007	4.4	5.5	8.6	12.7	18.3	22.4	24.22	23.0	14.8	10.7	4.2	
2008	1.02	3.71	7.62	12.4	17.8	21.6	21.9	22.6	15.4	12.25	7.07	
2009	-1.1	1.4	6.6	14.7	18.0	20.1	23.1	22.9	19.0	11.6	7.3	3.2
2010	-0.3	2.8	6.7	12.0	16.6	20.5	23.1	22.5	16.2	9.2	9.3	0.7
Multi-annual means	-1.2	0.4	6.0	11.3	16.4	19.6	21.6	20.8	16.9	11.3	5.7	1.4

Table 2

The monthly mean precipitations (mm) registered at Meteorological Station of Timişoara (2006-2010)

Specification	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2006	30.0	42.0	49.0	78.8	50.2	87.7	50.4	98.0	21.2	17.4		
2007	26.4	92.0	56.8	4.2	69.4	65.2	46.4	65.0	62.1	53	13.8	
2008	21.0	8.8	61.4	44.7	49	157	45.7	24.8	51.5	14.8	43.1	
2009	28.3	25.4	48.2	22.8	44.8	110.9	40.4	28.4	4.8	80.4	102.1	79.4
2010	65.0	76.5	32.9	56.6	118	131.3	25.0	81.8	40.5	40.0	48.1	74.6
Multi-annual means	40.9	40.2	41.6	50.0	66.7	81.1	59.9	52.2	46.1	54.8	48.6	47.8

The studied biological materials is represented by 14 varieties of fodder beet, which belong to the multigerm and monogerm forms of fodder beet, with different origins, which have been grown and studied for five years in the Didactic and

Experimental Station of U.S.A.M.V.B Timisoara. Starting with the second year, there was used to sow the seeds obtained from our experimental fields.

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 root and leaf weights were determined by weighing, while the plant weights were determined by adding the two parameters.

Statistical analyses have been performed by STATISTICA 8 package. (Petersen R.G., 1994; Mead R. and colab., 2002; Luminiţa Cojocariu and V.D. Lalescu, 2010).

Scheffe's procedure is one of the most popular of the post hoc procedures, the most flexible, and the most conservative. Scheffe's procedure corrects alpha for all pair-wise or simple comparisons of means, but also for all complex comparisons of means as well. Complex comparisons involve contrasts of more than two means at a time.

RESULTS AND DISCUSSION

In the following were calculated the basic descriptive statistics (mean, minimum, maximum, lower and upper quartiles, variance, standard deviation, skewness and kurtosis) for the root weights of the studied fodder beets (see Figure 1). It can be seen that the average of the root weights was 1108,35 g, the minimum of root weights was 712,53 g obtained at Vauriac genotype, the maximum of root weights was 1718,78 obtained for Brigadier genotype. The variance and the standard deviation were 75043,85 and 273,94 respectively. There were 6 genotypes with the root weights between 600-800 g, 12 genotypes with the root weights between 800-1000 g, 9 genotypes with the root weights between 1000-1200 g, 9 genotypes with the root weights between 1200-1400 g, 3 genotypes with the root weights between 1400-1600 g, 3 genotypes with the root weights between 1600-1800 g. The lower and upper quartiles were

901,89 and 1277,08 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 0,60 and -0,31 respectively.

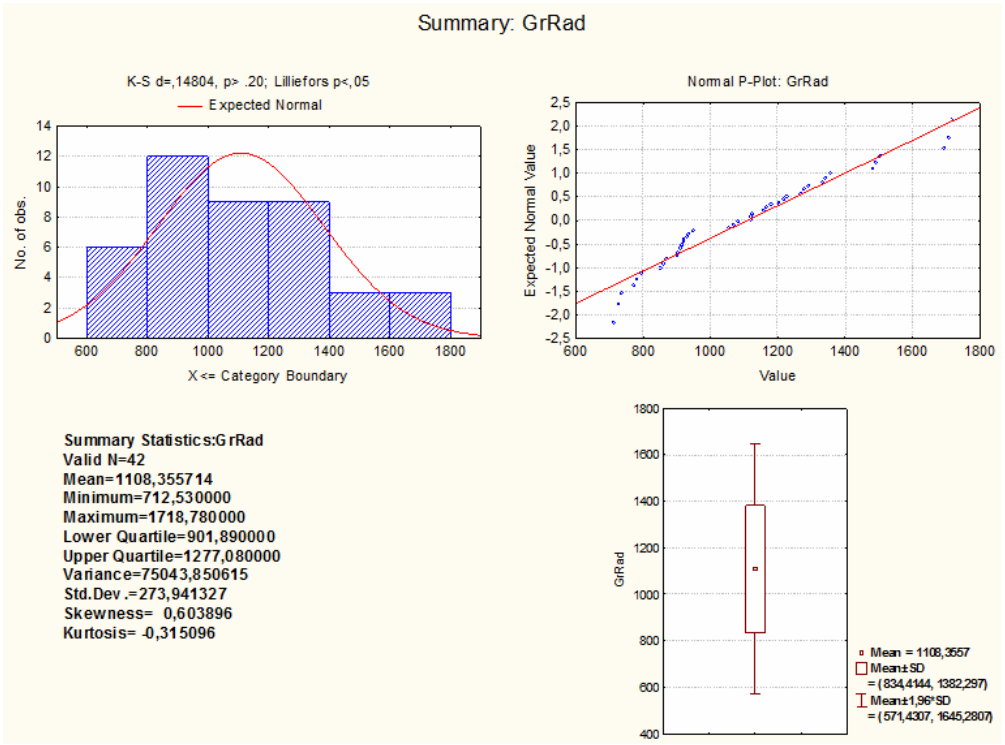

Fig. 1. Basic descriptive statistics for the root weights

The Scheffe tests were used in the analysis of variance for the comparisons of root weights 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, In particular, we have found that there are no statistical differences between Zentaur, Barbara and Taune genotypes; and between Magnus, Kyros and Polifuraj 2.

Table 3

Scheffe's test for the root weights

Scheffe test; root weight Probabilities for Post Hoc Tests

	Genotype	{1} 1706,6	{2} 783,33	{3} 1215,6	{4} 1491,7	{5} 859,66	{6} 935,40	{7} 723,60	{8} 1166,6	{9} 1341,7	{10} 916,66	{11} 1120,8	{12} 1277,1	{13} 910,99	{14} 1068,6
1	BRIGADIER		0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2	GONDA			0,000	0,000	0,000	0,000	0,008	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3	ZENTAUR				0,000	0,000	0,000	0,000	0,082	0,000	0,000	0,000	0,005	0,000	0,000
4	BELMONO					0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
5	JAMON						0,000	0,000	0,000	0,000	0,013	0,000	0,000	0,040	0,000
6	MAGNUS							0,000	0,000	0,000	0,988	0,000	0,000	0,910	0,000
7	VAURIAC								0,000	0,000	0,000	0,000	0,000	0,000	0,000
8	BARBARA									0,000	0,000	0,108	0,000	0,000	0,000
9	COLOSSE										0,000	0,000	0,002	0,000	0,000
10	KYROS											0,000	0,000	1,000	0,000
11	TAUNE												0,000	0,000	0,034
12	FELDHERR													0,000	0,000
13	POLIFURAJ 2														0,000
14	URSUS POLY														

The mean, the minimum, the maximum, the lower and upper quartiles, the variance, the standard deviation and the skewness and kurtosis for the leaf weights were shown in the Figure 2. It can be observed that the average leaf weight was 134,35g, the minimum leaf weight was 78,13g obtained at the Taune genotype, and the maximum leaf weight was 179g obtained for the Brigadier genotype. The variance and the standard deviation were 1042,88 and 32,29 respectively. There was 1 genotype with the leaf weight between 60-80g, 5 genotypes with the leaf weights between 80-100g, 12 genotypes with the leaf weights between 100-120g, 4 genotypes with the leaf weights between 120-140g, 8 genotypes with the leaf weights between 140-160g, 12 genotypes with the leaf weights between 160-180g. The lower and upper quartiles were 105 and 165,7 respectively. The skewness and kurtosis were -0,08 and -1,51 respectively.

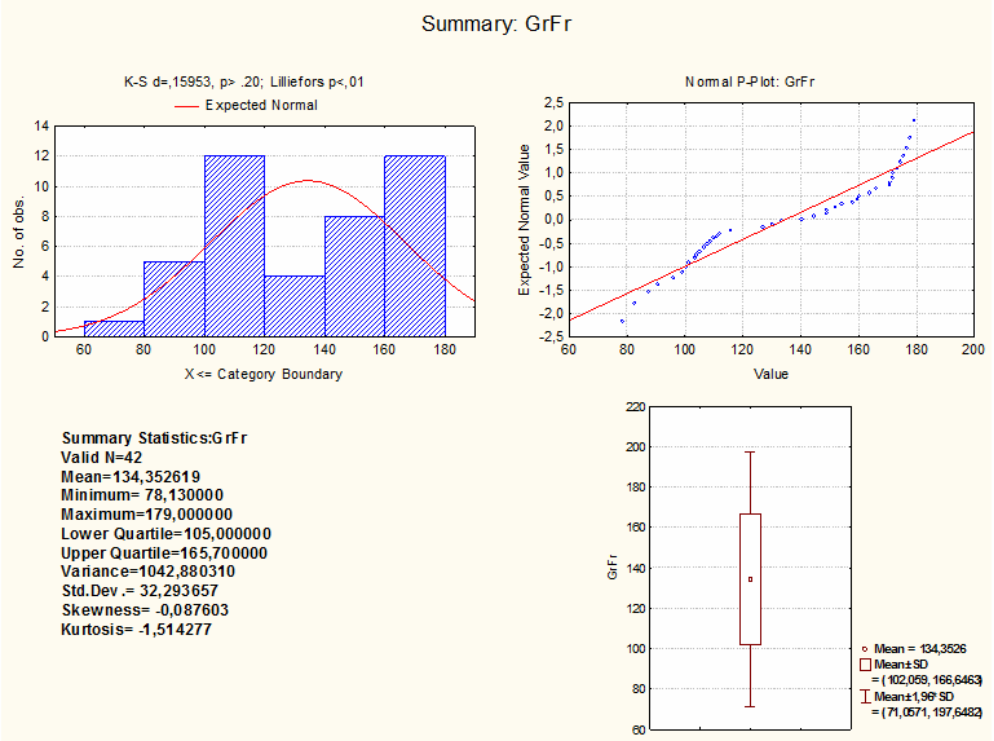

Fig. 2. Basic descriptive statistics for the leaf weights

It was used the Scheffe tests in the analysis of variance for the comparisons of the leaf weights in order to find the statistical differences between the studied genotypes (see Table 4). In general, there are statistically significant differences between the studied genotypes, but it have also been found that there are no statistical differences between Brigadier, Zentaur, Belmono, Jamon, Kyros, Polifuraj II and Ursus Poly genotypes; and between Magnus, Vauriac, Barbara, Colosse, Taune and Feldherr.

Table 4

Scheffe's test for the leaf weights

Scheffe test; leaf weight Probabilities for Post Hoc Tests

	Genotype	{1} 175,2	{2} 130,0	{3} 154,0	{4} 173,5	{5} 157,7	{6} 95,66	{7} 104,0	{8} 105,0	{9} 107,7	{10} 174,2	{11} 82,61	{12} 110,8	{13} 144,4	{14} 165,7
1	BRIGADIER		0,000	0,023	1,000	0,127	0,000	0,000	0,000	0,000	1,000	0,000	0,000	0,000	0,907
2	GONDA			0,005	0,000	0,000	0,000	0,001	0,003	0,013	0,000	0,000	0,060	0,381	0,000
3	ZENTAUR				0,054	0,999	0,000	0,000	0,000	0,000	0,039	0,000	0,000	0,904	0,716
4	BELMONO					0,249	0,000	0,000	0,000	0,000	1,000	0,000	0,000	0,000	0,980
5	JAMON						0,000	0,000	0,000	0,000	0,192	0,000	0,000	0,507	0,977
6	MAGNUS							0,966	0,922	0,860	0,000	0,542	0,300	0,000	0,000
7	VAURIAC								1,000	0,999	0,000	0,021	0,994	0,000	0,000
8	BARBARA									1,000	0,000	0,012	0,998	0,000	0,000
9	COLOSSE										0,000	0,003	0,999	0,000	0,000
10	KYROS											0,000	0,000	0,000	0,960
11	TAUNE												0,000	0,000	0,000
12	FELDHERR													0,000	0,000
13	POLIFURAJ 2														0,023
14	URSUS POLY														

The basic descriptive statistics for the plant weights were shown in the Figure 3. It can be remarked that the average plant weight was 1242,70g, the minimum plant weight was 811,73 obtained at the Vauriac genotype, the maximum plant weight was 1897,78g obtained for the Brigadier genotype. The variance and the standard deviation were 80854,68 and 284,34 respectively. There were 6 genotypes with the plant weights between 800-1000 g, 13 genotypes with the l plant weights between 1000-1200 g, 13 genotypes with the plant weights between 1200-1400 g, 4 genotypes with the plant weights between 1400-1600 g, 3 genotypes with the plant weights between 1600-1800 g, 3 genotypes with the plant weights between 1800-2000 g. The lower and upper quartiles were 1034,4 and 1387,91 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 0,7 and -0,004 respectively.

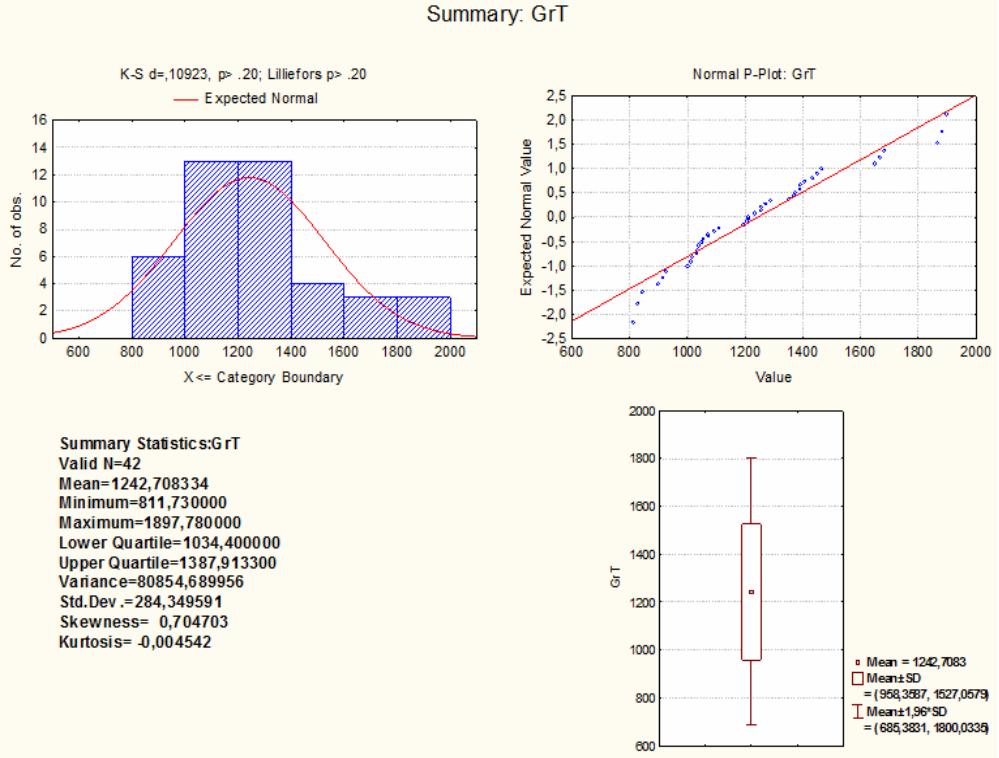

Fig. 3. Basic descriptive statistics for the plant weight

The Scheffe tests in the analysis of variance were performed for the plant weights in order to find the statistical differences between the studied genotypes (see Table 5). It can be concluded that in general, there are statistically significant differences between the studied genotypes. It have also been found that there are no statistical differences between Zentaur, Colosse and Feldherr genotypes; between Jamon, Magnus, Kyros and Polifuraj 2; between Barbara, Taune and Ursus Poly.

Table 5

Scheffe's test for the leaf numbers

Scheffe test; plant weight; Probabilities for Post Hoc Tests															
	Genotype	{1} 1880	{2} 913,3	{3} 1369,7	{4} 1665,2	{5} 1017,3	{6} 1031,1	{7} 827,60	{8} 1271,6	{9} 1449,4	{10} 1090,9	{11} 1203,4	{12} 1387,9	{13} 1055,4	{14} 1234,2
1	BRIGADIER		0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
2	GONDA			0,000	0,000	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,000	0,000	0,000
3	ZENTAUR				0,000	0,000	0,000	0,000	0,000	0,011	0,000	0,000	0,999	0,000	0,000
4	BELMONO					0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
5	JAMON						0,999	0,000	0,000	0,000	0,028	0,000	0,000	0,808	0,000
6	MAGNUS							0,000	0,000	0,000	0,159	0,000	0,000	0,993	0,000
7	VAURIAC								0,000	0,000	0,000	0,000	0,000	0,000	0,000
8	BARBARA									0,000	0,000	0,050	0,000	0,000	0,827
9	COLOSSE										0,000	0,000	0,131	0,000	0,000
10	KYROS											0,000	0,000	0,874	0,000
11	TAUNE												0,000	0,000	0,952
12	FELDHERR													0,000	0,000
13	POLIFURAJ 2														0,000
14	URSUS POLY														

CONCLUSIONS

The results of this paper indicate the existence of significant differences with respect to the production characters in the analyzed varieties, which allows us to use them as criteria in practice.

There were calculated the basic descriptive statistics (mean, minimum, maximum, lower quartile, upper quartile, variance, standard deviation, skewness, kurtosis) for the root weights, the leaf weights and the plant weights of the Brigadier, Gonda, Zentaur, Belmono, Jamon, Magnus, Vauriac, Barbara, Colosse, Kyros, Taune, Feldherr, Polifuraj 2 and Ursus Poly genotypes of fodder beets. Then it was performed pairwise comparisons between the above genotypes using the Scheffe'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 the root weights, the leaf weights and the plant weights, but we also found out that:

- from the point of view of the root weights, there are no statistical differences between Zentaur, Barbara and Taune genotypes; and between Magnus, Kyros and Polifuraj 2 genotypes;

- from the point of view of the leaf weights, there are no statistical differences between Brigadier, Zentaur, Belmono, Jamon, Kyros, Polifuraj 2 and

Ursus Poly genotypes; and between Magnus, Vauriac, Barbara, Colosse, Taune and Feldherr genotypes.

- from the point of view of the plant weights, there are no statistical differences between Zentaur, Colosse and Feldherr genotypes; between Jamon, Magnus, Kyros and Polifuraj 2; between Barbara, Taune and Ursus Poly.

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