Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 2, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE BEHAVIOR OF SOME FIG (*Ficus carica* L.) GENOTYPES IN NORTHEN AREA OF BUCHAREST

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Abstract

At the Faculty of Horticulture in Bucharest, an important collection of fig (Ficus carica L.) genotypes found in Romania and some introduced from Italy, was started in 2015 and since then its evaluation is in process. The paper presents the results regarding the behaviour of some fig genotypes grown in the climatic conditions of Northern area of Bucharest, using an organic crop technology. Fruits measurements in accordance with IPGRI descriptors are presented. Fruit biochemical characteristics as soluble solids, total solids, acidity, glucose and fructose content are also presented. All the analyzed parameters were influenced by the genotype. The results showed that some of the local and foreign genotypes had a late harvesting or very small fruits. The genotypes that produced good results concerning fruit quality, such as: size, biochemical composition and cracking resistance, will be studied in the next years in order to observe their productivity, earliness and resistance to biotic and abiotic stresses.

Key words*: Ficus carica, vigour, yield, fruit composition.*

INTRODUCTION

In Romania, the socio-economic importance of figs in this moment is very low, but in recent years we are witnessing an increased interest of farmers in cultivating these fruit species. Thus, it is necessary to identify some fig genotypes that are adapted to the conditions in our country and have high pomological value.

Although the climatic conditions in our country are quite restrictive for the fig culture, there are areas where we can find favourable conditions such as: Mehedinți (Șvinița), Dolj, Dobrogea, and Southwest part of the country (Stănică and Branište, 2011). In Dobrogea, the fig trees can be found in a semi-spontaneous state, and in Șvinița there is a compact surface of 120 ha with fig plantations, being unique in Europe in terms of surface area. The fig is also found in the Timișoara area, between Buziaș and Drobeta Turnu-Severin, in Câmpia Română (Tomescu, 2014), and in Bucharest it was frequently cultivated in people's gardens (Stănică, 2017).

The fig belongs to the *Moraceae* family. It is assumed to be the first plant cultivated by man, before millet and wheat (Kislev, 2006), which attracted researchers to study the genetic variability of this species. There are over 1000 genotypes, of which, due to their superior taste qualities, over 600 were studied by the American horticulturist Condit (1947).

The Swedish botanist De Candolle, based on the hypothesis that the frequent appearance of these species in the wild in certain areas is a determining criterion, considers the area of origin Caria, Syria and the Mediterranean Basin. Fig cultivation is widespread in this area because it is a species that adapts well to different soil and climate conditions (Mars, 2003). It is considered a xerophilous plant (Minonne et al., 2011), does not withstand temperatures below -16°C, the maturity of fruit consumption is achieved at temperatures of 20-21°C (Chira, 2009; Cimpoieș, 2018).

It is a unisexual dioecious species, being represented by the common fig tree that has female flowers and the caprifig with functional male flowers. Their spread in the wild is found in a similar proportion (Valdeyron and Lloyd, 1979). The cultivated fig tree is of 3 types: a) Adriatic type (common) that develops parthenocarpic fruits, b) Smyrna type that bears

fruit by pollination and c) San Pedro type that bears fruit at the first harvest (breba) parthenocarpic and at the second harvest (main crop) requires pollination (Giraldo et al., 2008). In our country 10-12-15 kg/plant are obtained (Hoza, 2001), in Provance-France 33 kg/plant (8 t/238 plants) (Vidaud, 1997), while in areas favorable to fig fruiting 40-80-100 kg/plant (Accorsi and Beldi, 2011). The fruit is a sicone (Hoza, 2001; Hoza, 2003; Berg, 2003). The average weight of the fruits from the main crop varies between 12.6 g 'Celeste', 18.6 g 'LSU Purple', 28.1 g 'Florentine' and 43.6 g 'LSU Gold' (O'Rourke et al., 2004); 20-25 g 'Marsellaise' and 50-70 g 'Bourjassotte' (Vidaud, 1997); 22 g 'Zimica', 24 g 'Rezavica' and 69 g 'Zeleni Matalon', 77 g 'Crna Bruzetka' (Bandelj Mavsar et al., 2008).

Glucose and fructose are the main sugars found in figs, representing 51% and 44% of total sugars, respectively, along with sucrose (4.5%) and maltose (0.6%) but in much smaller quantities (Bandelj Mavsar et al., 2008). Fresh fruits contain between 13-25% carbohydrates, vitamins B1, B2, B6, C, and Pp, fiber (Hoza, 2000), significant amounts of Ca, Zn, Fe, K, Mg, Na but they vary depending on the cultivation area (Lo Turco et al., 2020).

Leaves and fruits of the fig trees have nutraceutical characteristics, being recommended in alleviating diseases such as: anemia, cough, urinary tract inflammation, senescence (Gherman, 2013), cancer (Abdel-Rahman et al., 2021), diabetes (Wojdylo et al., 2016).

The fig usually multiplies clonally through cuttings, causing the misidentification of genotypes by the appearance of synonyms and homonyms in their name (do Val et al., 2013).

The fig has a rich genetic diversity because it has not undergone intensive breeding programs, but requires the correct identification and classification of genotypes (Perez-Jiménez et al., 2012). Some of pomological characterizations or identification of fig genotypes studies were performed in France (Vidaud, 1997), Morocco (Khadari et al., 2008), Tunisia (Aljiane et Ferchichi, 2008), Istria (Bandelj Mavsar et al., 2008), Albania (Koka, 2008), Iran (Khadivi et all., 2018), Canary Islands (Gil et al., 2008), and in Romania, at the Faculty of Horticulture - USAMV of Bucharest, it was conducted the first research of this kind by Stănică (2017), Ahmad et al. (2017).

In order to preserve the genetic diversity of the local fig genotypes, a collection of germplasm was made at the Faculty of Horticulture in Bucharest. A good management and conservation of the local varieties implies a prior morphological evaluation of them. This study characterizes the morphological variability of some fig genotypes from Romania and Italy. The objective of the study is to find those genotypes that have some special agronomic traits that make them interesting for farmers to have a fig orchard.

MATERIALS AND METHODS

The area where the research is carried out is in the Northern part of Bucharest, in the experimental field of the Faculty of Horticulture, Bucharest. The geographical coordinates are 44°28'10" N lat. and 26°04'00" E long., and the altitude is 78 m above the sea level. The climate is characterized by hot, dry summers, cold winters, 10.5°C annual temperatures and the annual average of precipitations sums up to 550-600 mm.

The vegetal material is represented by the fig trees, on their own roots, come through cuttings from the figs grown in Romania and Italy. The cuttings were rooted in the greenhouse of the Faculty of Horticulture.

The genotypes studied are from the southern part of the country: 'Galben mare' from Braniștea, GR; 'Brazi' from Brazi, PH; 'Stork', '1 Mai', 'Piața Obor', 'Dr. Constantinescu' from Bucharest, 'Smochin negru' and 'Ploiești nr.1' from Ploiești, PH, 'Negoiești 01' from Negoiești, PH; 'Viscool' from Mărăcineni, AG; from the western part: 'Oli Timișoara' from Timișoara, TM; 'Săvârșin' from Săvârșin, AR; from south-western part: 'Rot negru' from Șvinița, CS; and from Italy: 'Awitato', 'Bianco Etna', 'Passulana nera', 'Cilento nero', 'Fig primizia'.

On these fig genotypes we made determinations and measurements, such as: harvest period, tree vigour and average fruit weight. Biochemical analyses, such as: soluble solids, glucose and fructose, total dry matter and titrable acidity (g/kg citric acid).

Determinations were performed in the Researcher Centre for Study of Food Quality and Agricultural Products, USAMV of Bucharest. The period analyzed in this study was 2020 and 2021 years.

The sugar content, expressed in %Brix, was determined using the Milwaukee MA871 digital refractometer, the glucose content using the Milwaukee MA872 digital refractometer, and the fructose content using the Milwaukee MA873 digital refractometer.

The acidity of the figs was determined by the titrimetric method. 10 fruits from the same sample have been mashed, with the Retsch GM 200 grinding mill, until a homogeneous paste resulted from which 5g of sample were weighed on the analytical balance over which 25ml of double-distilled water were added. The sample was homogenized using a magnet by inserting a Teflon-coated iron bar into the suspension. The pHmeter of the automatic titrator was rinsed with double-distilled water and swabbed with a paper towel after which it was placed in the sample. It was automatically titrated with 0.1 N NaOH to pH 8.1 or 8.2 depending on the sample. The initial and final pH were read, as well as how many ml of 0.1 N NaOH were consumed to the desired pH. The device used to determine acidity was the TitroLine easy automatic titrator. The acidity was expressed in citric acid (g/kg). Determinations were performed in triplicate.

The results were calculated according to the following formula and expressed as a percentage:

$$\text{Titratable acidity (g/kg citric acid)} = (V \times N \times C \times 100) / m$$

V - volume of NaOH consumed (ml), N - normality of NaOH, C - equivalent citric acid (0.0064), m - mass of sample (g)

The titratable acidity was determined according to the official method AOAC 942.15 and Saad et al (2014).

The determination of the total dry matter was carried out by introducing the fig paste into the Memmert oven, model 200, at 105°C for a period of 24 hours. Determinations were performed in triplicate.

RESULTS AND DISCUSSIONS

Total yield

Regarding the production, it was noticed that the best results in terms of yield were obtained by the genotypes of Romanian origin: 'Stork' (17.73 t/ha), 'Galben mare' (12.33 t/ha) and 'Rot negru' (8.55 t/ha), whilst the smallest was been recorded for the Italian 'Bianco Etna' genotype. Although it is a genotype that produces a lot of fruits, these cannot be marked because they do not reach maturity (ripen), 'Bianco Etna' being the latest genotype among those analyzed by us (Figure 1).

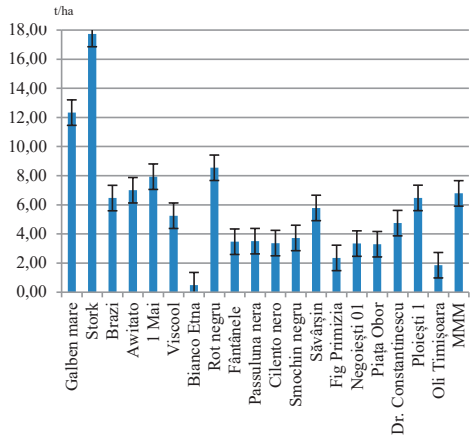

Figure 1. Total yield in 2021 year (t/ha)

Here there are charts of harvesting dynamic of genotypes with a similar period of fruit ripening in 2021. The genotypes were divided into the earliest, middle and latest ones. It is noticed that the best results for the earliest genotypes for the fourth year plants were registered between 9 - 16 September 2021 and around 7 October 2021 (Figure 2), whilst for the third year plants around 9, 16, 27 September 2021 (Figure 3).

For the middle and latest genotypes we had the best results, in terms of yield, around 17 September, 29 September, 7 October and late October, for the fourth year plants (Figure 4), whilst for those of third year between 16-26 September and around 8 and 20 October 2021 (Figure 5).

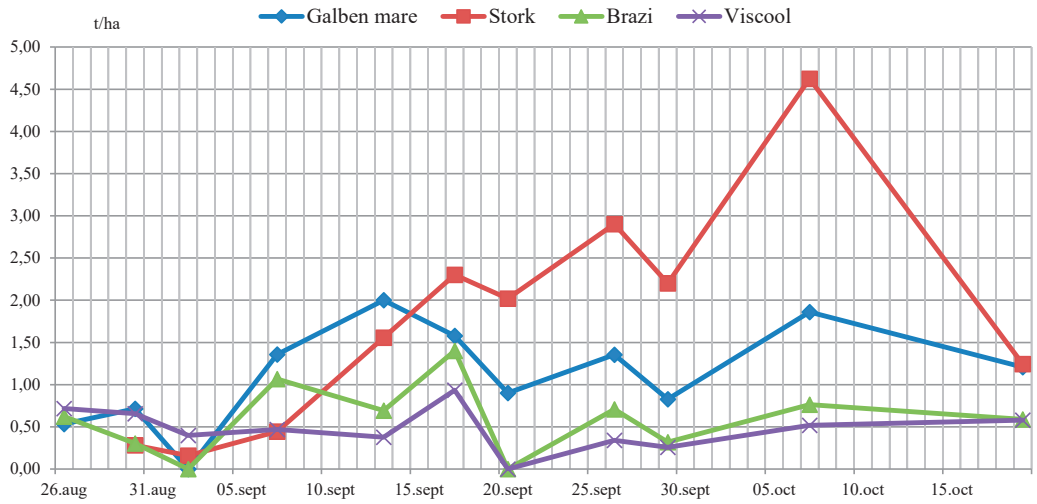

Figure 2. Yield dynamic (t/ha) of the earliest genotypes for the fourth year plants. The thickened points represent the days on which the harvest was carried out and the quantities of figs that were harvested on those days

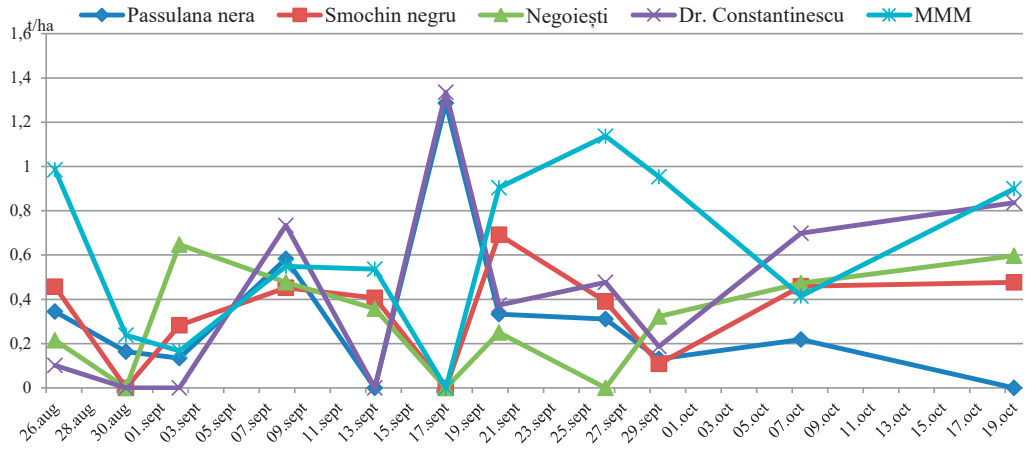

Figure 3. Yield dynamic (t/ha) of the earliest genotypes for the third year plants. The thickened points represent the days on which the harvest was carried out and the quantities of figs that were harvested on those days

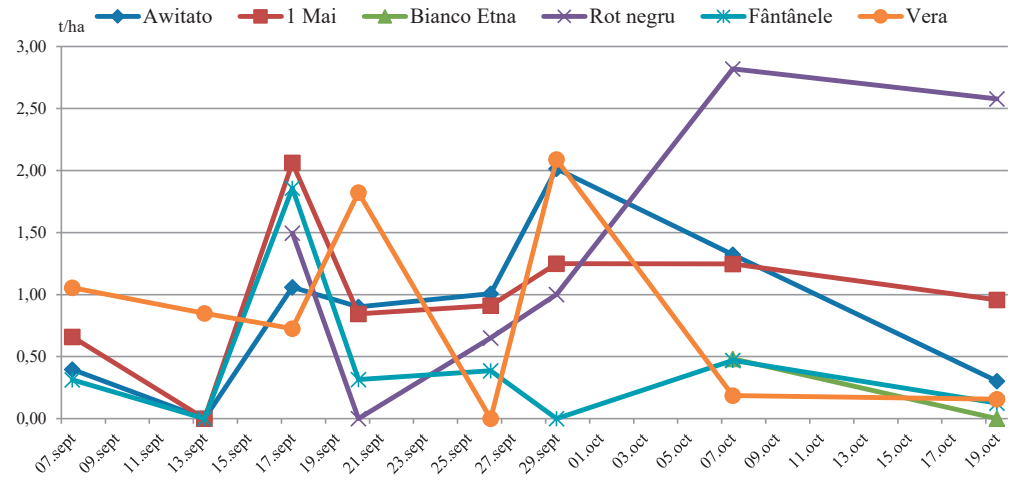

Figure 4. Yield dynamic (t/ha) of the middle and the latest genotypes for the fourth year plants.The thickened points represent the days on which the harvest was carried out and the quantities of figs that were harvested on those days

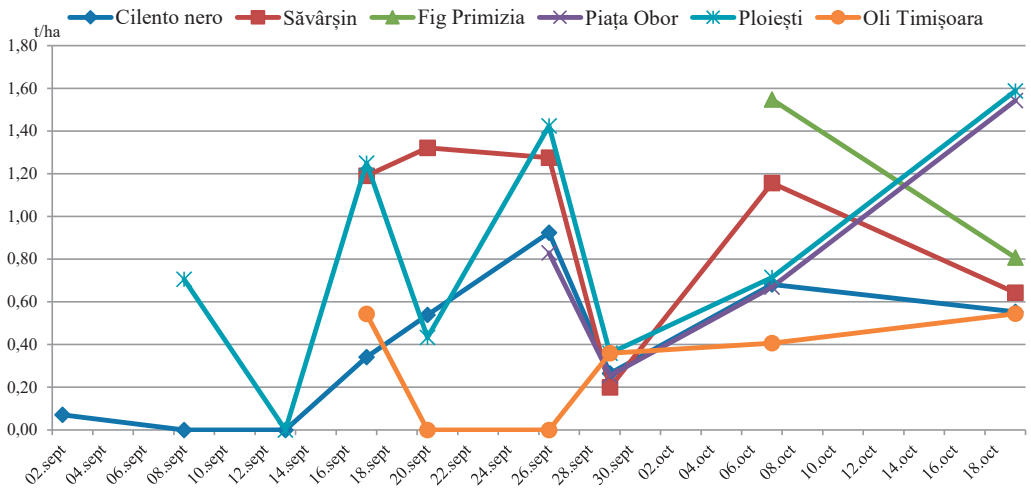

Figure 5. Yield dynamic (t/ha) of the middle and the latest genotypres for the third year plants. The thickened points represent the days on which the harvest was carried out and the quantities of figs that were harvested on those days

Harvesting time

For the studied genotypes, the second harvest (main crop) was analyzed and the results showed different harvesting period.

According to the harvest timeline for the two years 2020 and 2021, the earliest genotypes are: 'Galben mare', 'Brazi' and 'Viscool'.

We notice that in the case of earliest and latest genotypes, we have a decade or two delay in fruit ripening due to the late accumulation of useful temperatures in 2021.

This condition has little impact on genotypes with a middle maturity (Table1).

Table 1. Harvest schedule

Month		August		September			October		
		Decade		Decade			Decade		
Genotype	Year	2	3	1	2	3	1	2	3
'Galben mare'	2020								
	2021								
'Stork'	2020								
	2021								
'Brazi'	2020								
	2021								
'Awitato'	2020								
	2021								
'1 Mai'	2020								
	2021								
'Viscool'	2020								
	2021								
'Bianco Etna'	2020								
	2021								
'Rot negru'	2020								
	2021								
'Fântânele'	2020								
	2021								
'Passulana nera'	2020								
	2021								
'Cilento nero'	2020								
	2021								
'Smochin negru'	2020								
	2021								
'Săvârșin'	2020								
	2021								
'Fig primizia'	2020								
	2021								
'Negoiești'	2020								
	2021								
'Piața Obor'	2020								
	2021								
'Dr. Constantin'	2020								
	2021								
'Ploiești'	2020								
	2021								
'Oli Timișoara'	2020								
	2021								
MMM	2020								
	2021								

Towards the end of the vegetation period, from some genotypes ('Stork' 3.35 t/ha; 'Rot negru' 3.02 t/ha; 'Galben mare' 0.83 t/ha) significant quantities of fruit in the veraison state were harvested, but which due to unfavorable temperatures no longer reach the maturity of consumption. These fruits are smaller in size ('Rot negru' 17 g; 'Galben mare' 14.96 g; 'Stork' 14.92 g) and can be used successfully in the preparation of jams, caramelized figs or pickles.

Plant vigour

The comparison of the growth vigour was performed, as well (Figure 6). The plants on row R4 were planted in 2017, those on row R3 in 2018.The planting distances are slightly bigger on row R4. Comparing the vigour of the plants at the same age (three years old) we notice that those on R4 (the blue ones) were slightly more vigouros than those on row R3 (the red ones). The most vigouros plants were: 'Stork', 'Bianco Etna', 'Galben mare' (all of them are on row R4). The lowest growth vigour have had the following genotypes: MMM, 'Oli Timișoara' and 'Fig primizia' on row R3, 'Fântânele' and 'Brazi' on row R4.

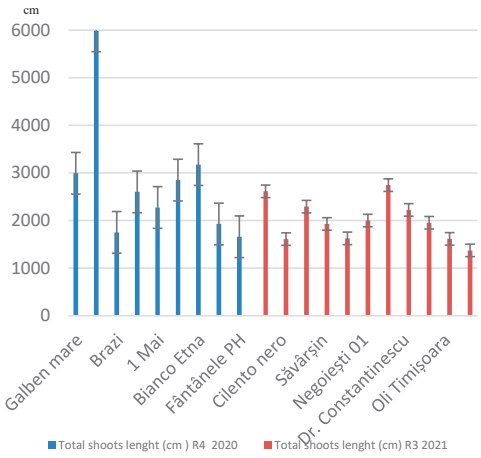

Figure 6. Total shoots length (cm)

Fruit characteristics

The average fruit weight was between 11.34 g/fruit ('Smochin negru'), and 39.57 g/fruit ('Săvârșin') in 2021 (Figure 7) and it was lower than in 2020 (Figure 8) when this was between 17.16 g/fruit ('Negoiești 01') and 54.11 g/fruit ('Săvârșin'), but the sugar content was higher, which indicates that the sugar concentration increased in 2021 compared to 2020.

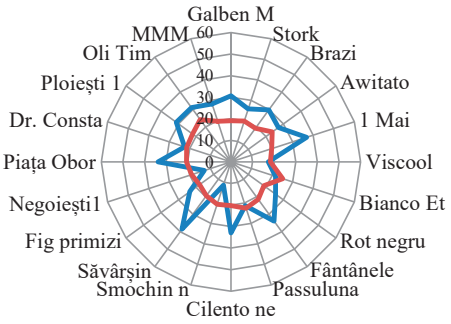

Figure 7. Average fruit weight (g) and Sugar content (% Brix) in 2021

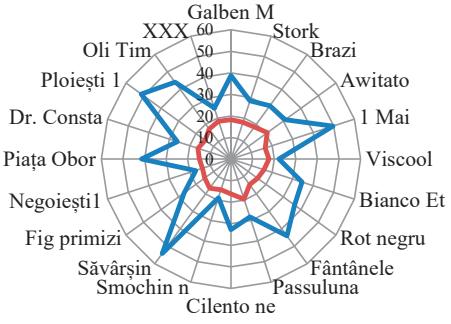

Figure 8. Average fruit weight (g) and Sugar content (% Brix) in 2020

We have had the same situation in case of glucose and fructose, their values being higher in 2021 than in 2020 (Figure 9).

We have noticed that the genotypes with the highest dry matter content (Figure 10) were the Italian ones: 'Bianco Etna' (25.32%), 'Awitato' (25.12%) and 'Passulana nera' (23.78%), this being in accordance with the soluble substances content.

Figs are alkaline fruits with an extremely low titrable acidity (g/kg citric acid), the highest values being observed in the genotypes 'Stork' (0.26 g/kg), 'Smochin negru' and 'Negoiești 01' (0.21 g/kg) (Figure 11).

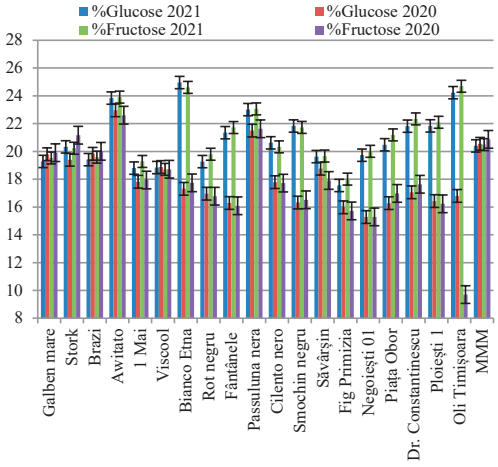

Figure 9. Glucose and fructose content (%)

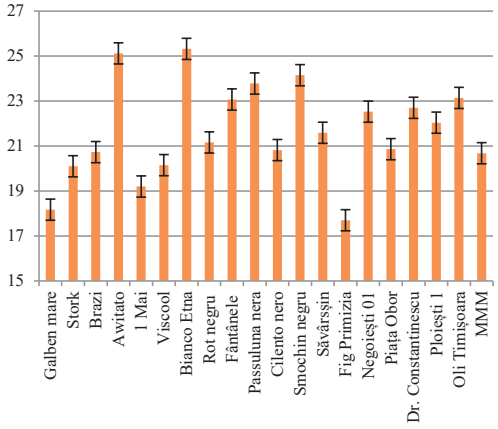

Figure 10. Total dry matter (%)

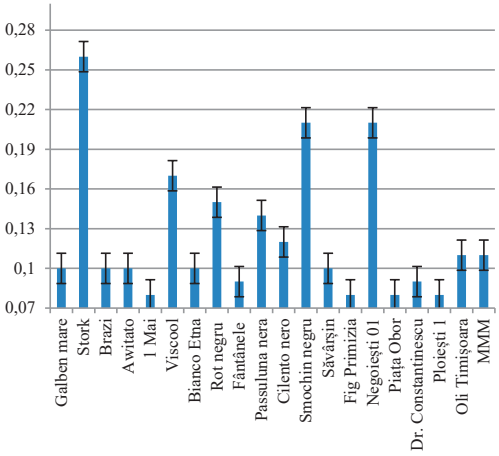

Figure 11. Acidity (citric acid g/kg)

CONCLUSIONS

The Romanian genotypes are the best adapted to the climatic conditions in Romania, being the earliest genotypes and, also, the ones which have had the highest yields per hectare.

Also, for some genotypes, significant quantities of fruit in the veraison state, that due to unfavorable conditions do not reach maturity for consumption, can be harvested and used to produce products such as jam, caramelized figs or pickles.

The best productions were registered in the second decade of September and the second decade of October.

The plants of italian origin, such as 'Bianco Etna', 'Awitato', 'Passulana nera' and 'Cilento nero' have had a good evolution, beeing the genotypes with the highest sugar and dry matter content, a very tasty fruits and good cracking resistance.

A high morphological variability was found, so that in the future new determinations will be made for a more precise characterization of the genotypes from the germplasm collection.

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