Scientific Bulletin. Series F. Biotechnologies, Vol. XXVIII, No. 1, 2024
ISSN 2285-1364, CD-ROM ISSN 2285-5521, ISSN Online 2285-1372, ISSN-L 2285-1364

STUDY ON THE EVALUATION OF POMOLOGICAL, BIOCHEMICAL, AND ORGANOLEPTIC PARAMETERS OF VARIETIES APRICOT

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Abstract

Fruit production influences people's health due to its biochemical compounds. Apricot fruit is rich in potassium, magnesium, and calcium and contains sufficient glucose, sucrose, fructose, vitamins A and E, antioxidant compounds, beta-carotene, and lycopene. Cultivars are an essential factor in determining the final yield of the product, the quality of the fruits produced, the vegetative growth of the plant, and the stress resistance. Several studies have been conducted to increase fruit quality in important fruit indicators such as color, taste, carbohydrate content, titratable acidity, fruit size, firmness, time of fruit harvest, and ripening time. The present study presents the results for more than 25 cultivars of fruit quality parameters correlated to canopy shape or rootstock.

Key words: *titratable acidity, total soluble solids, dry matter.*

INTRODUCTION

Besides satisfying people's nutritional needs, fruit production also influences people's health due to its biochemical compounds (Akin et al., 2008). Apricot is used as fresh, dried, and processed fruit (Altindag et al., 2006; Özdoğru et al., 2015). Apricots are rich in potassium, magnesium, and calcium, and it has been explained that some organic acids, sugar, and phenolic compounds are also present in them (Muradoğlu et al., 2011; Ali et al., 2011). In addition, they contain sufficient glucose, sucrose, fructose, vitamins A and E, antioxidant compounds, beta-carotene, and lycopene (Muradoğlu et al., 2011). The lycopene in apricots is effective against cancer and protects the body from the dangers of high cholesterol followed by heart disease (Iordanescu et al., 2018).

The taste and color of apricots are influenced by the amount of carotenoids and phenolic compounds (Huang et al., 2013). It has been found that the amount of organic acids and sugar effectively determines the taste and smell of the fruit in apricots (Miloševic et al., 2016). In a study conducted by Gundogdu (2019), it was found that using different rootstocks affects some of the phytochemical fruit parameters. Cultivars are essential in determining the final yield in fruit trees and orchards (Akin et al., 2008). The selection of the suitable rootstock influences the final yield of the product and the quality of the fruits produced, the vegetative growth of the plant, as well as the stress resistance (Son & Küden, 2003; Şahiner et al., 2013; Milosevic et al., 2011; Arıcı, 2008).

Selecting the suitable rootstock has to be done according to the growing conditions (Milošević & Milošević, 2019b). Among its objectives are the optimal development of the plant, the increase of the quality parameters of the fruits, the improvement of the yield, and the resistance to biotic and abiotic stress (Zhebentyayeva et al., 2012). In other research, the importance of the cultivar (Mratinic et al., 2011; Iordanescu et al., 2012), geographical conditions of the region (Milosevic et al., 2010; Campbell et al., 2011), cultivation system (Leccese et al., 2010), ripening process (Ayour et al., 2017), and protection and processing technologies (Hussain et al., 2013) fruit related indicators were also discussed.

Several studies have been conducted to increase fruit quality in important fruit indicators such as color, taste, carbohydrate content, titratable acidity, fruit size, firmness, time of fruit harvest, and ripening time. (Oprita et al., 2020).

MATERIALS AND METHODS

The study was conducted for 30 apricot cultivars planted in the Experimental Fruit Field of the Faculty of Horticulture in Bucharest, established in 2017, with two canopy shapes – Trident and Bi-Baum® (Al-Suwaid et al., 2023).

From the sample of 20 fruits, each fruit was measured with the digital caliper, determining the length and the two diameters.

The shape index was determined using the formula: i = l/ [(d1+d2)/2].

The share of the weight of the pulp, respectively of the seeds, from the total average weight of the fruit was determined. Total acidity (expressed in g malic acid/100 g fresh product), dry matter (%), and total soluble solids (º Brix) were determined.

RESULTS AND DISCUSSIONS

The series of cultivars cultivated in the Trident system

Fruit length study for different cultivars in two consecutive years showed that the most extended fruit length in the first year belonged to Primaya/SJA, Anegat/M29C, and Faralia/M29C cultivars. In the second year, it belonged to Farbali/M29C cultivars. The values varied between 45.94 and 55.95 mm in 2021 and 38.12 and 55.48 mm in 2022 (Table 1).

Table 1. Fruit length in different cultivars in the period 2021-2022 (cm) at the Trident system

Variant	2021	2022
Anegat/M29C	55.95a	45.16f
Faralia/M29C	55.73a	52.83bc
Farbali/M29C	46.45b	55.48a
Farbali/SJA	48.35b	54.72ab
Farbela/M29C	47.28b	52.51bc
Farclo/M29C	48.18b	48.32e
Farclo/SJA	48.53b	50.24df
Farely/SJA	45.94b	45.35f
Farlis/M29C	47.78b	44.30f
Fartoly/SJA	46.01b	38.12g
Primaya/SJA	55.16a	52.24cd
Average	49.47b	49.02e

Studying the **average fruit diameter** of the different varieties analyzed, it was found that the fruits produced by the Primaya/SJA cultivar had the highest value of this index compared to other varieties in both years of the study. In addition, it was found that in the second year, the fruits of Farbali/M29C and Farbali/SJA had values similar to Primaya/SJA, higher compared to other varieties. The values varied between 41.55 and 53.26 mm in 2021 and 38.47 and 51.87 mm in 2022, respectively.

The fruit shape index had values generally above unity, the fruits having an ovoid shape, Fartoly/SJA being the only variety with round/symmetrical fruits.

Absorption difference index (IAD)

The fruits were harvested after evaluating the absorption difference index determined with the DA-meter. This index was determined for each fruit and at the time of analysis. The values varied between 0.07 and 0.36 in 2021 and between 0.09 and 0.39 in 2022, indicating the degree of ripening of the fruits (Table 2).

Table 2. Index of absorbance difference (AD index) at the time of analysis in cultivars in the period 2021-2022 at the Trident system

Variant	2021	2022
Anegat/M29C	0.19c	0.14e
Faralia/M29C	0.26bc	0.28bc
Farbali/M29C	0.36a	0.33ab
Farbali/SJA	0.28abc	0.17de
Farbela/M29C	0.09d	0.11e
Farclo/M29C	0.06d	0.23cd
Farclo/SJA	0.22c	0.38a
Farely/SJA	0.31ab	0.31abc
Farlis/M29C	0.26bc	0.11e
Fartoly/SJA	0.26bc	0.39a
Primaya/SJA	0.28abc	0.09e
Average	0.23e	0.23cd

Weight pulp

In the first and second years of the study, it was found that the Primaya/SJA cultivar presented the highest comparative values with the others. In the second year, Farbali/SJA and Farbali/M29C had significantly similar values. Values ranged between 41.02 and 82.60 g in 2021, respectively, and between 28.83 and 77.51 g in 2022.

Kernel weight

Values ranged between 2.49 and 4.77 g in 2021 and 2.46 and 4.96 g in 2022, respectively. Fartoly/SJA and Farlis/M29C showed the highest values in 2021; in the second year of study, the highest value was observed in Farbali/M29C. In the second year, the other cultivars did not show significant differences in kernel weight.

Total soluble solids content. The highest value in the first year was observed at Fartoly/SJA, and the lowest was observed at Primaya/SJA. In the second year, the highest amount was observed in the cultivars Farely/SJA, Farbali/SJA, and Farbela/M29C, and the lowest amount was observed in the cultivar Primaya/SJA (Table 3). Values ranged between 8.19 and 14.30 Brix in 2021 and between 8.1 and 17.06 Brix in 2022.

Table 3. Total soluble solids content in different cultivars in the Trident system (2021-2022)

Variant	2021	2022
Anegat/M29C	9.63fg	15.50ab
Faralia/M29C	11.51cde	13.46c
Farbali/M29C	8.90gh	16.43a
Farbali/SJA	10.42ef	14.03bc
Farbela/M29C	12.40bcd	15.98a
Farclo/M29C	12.61bc	12.90c
Farclo/SJA	13.06ab	13.63c
Farely/SJA	11.00def	17.06a
Farlis/M29C	11.83bcde	9.82d
Fartoly/SJA	14.30a	13.63c
Primaya/SJA	8.19h	8.10e
Average	11.23cdef	13.63c

Total acidity

Examining the changes in total titratable acidity values in different cultivars cultivated in the Trident system showed that the highest value of this parameter in the first year was observed in the cultivars Primaya/SJA, Farbela/M29C, and Farbali/M29C (1.7567 g acid malic/100 g fw)) and in the second year to the cultivar Farbela/M29C (1.980 g acid malic/100 g fw). The lowest values were at Fartoly/SJA (0.530 g acid malic/100 g fw) and Faralia/M29C (0.660 g acid malic/100 g fw) in the first year, and Farlis/M29C in the second year (0.590 g acid malic/100 g fw) (Table 4).

Table 4. Tritable total acidity in different cultivars in the Trident system (2021-2022)

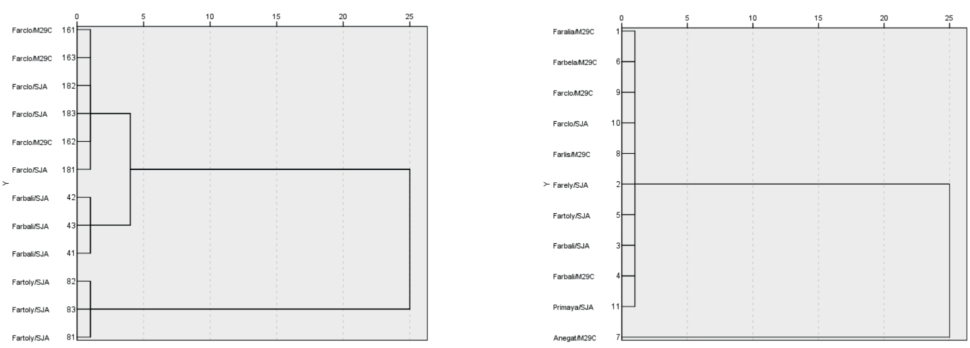
Variant	2021	2022
Anegat/M29C	0.8167bc	1.2900d
Faralia/M29C	0.6600c	0.9175e
Farbali/M29C	1.7567a	1.1833d
Farbali/SJA	0.8067	1.4500c
Farbela/M29C	1.8100a	1.9800a
Farclo/M29C	0.8867bc	1.1867d
Farclo/SJA	1.1067b	1.1833d
Farely/SJA	1.1267	1.0250e
Farlis/M29C	0.8167bc	0.5900f
Fartoly/SJA	0.5300c	1.2767d
Primaya/SJA	1.9200a	1.7800b
Average	1.1124b	1.2570d

Total dry matter

The analysis of the content in the total dry matter found that the cultivar Farclo/M29C had the highest value compared to other cultivars in both years. In the first year of study, the cultivars Farclo/SJA and Fartoly/SJA had similar values. In the years 2021, values ranged between 7.92% (Primaya/SJA) and 16.50% (Fartoly/SJA), and in 2022, between 9.95% (Anegat/M29C) and 18.72% (Farclo/M29C).

Cluster analyze

In the analysis of the cultivars in the first and second years, according to the studied parameters, the results showed that the studied cultivars in the first year were divided into three different groups. In contrast, they were divided into two groups in the second year. In 2022, the Anegat/M29C cultivar was placed in one group, and other cultivars in another group (Figure 1).



2021 2022

Figure. 1. Cluster analysis of different cultivars in the Trident system

The series of cultivars grown in the Bi-Baum system, 2.0 m per row

Fruit Length

The study of the fruit length index showed that the highest fruit length in the first year was observed in cultivars Delice/M29C (53.75 mm) and Medflo/M29C (51.65 mm). In the second year of the study, the average length of the fruits of the cultivars Wonder Cot/M29C (51.42 mm) and Lady Cot/M29C (50.95 mm) was significantly higher compared to other cultivars.

Average fruit diameter

In the investigation of the average diameter index, it was found that, in the first year of the study, the highest value of this index was observed at Delice/M29C (52.33 mm), while in the second year at Delice/M29C (49.92 mm) and Lady Cot/M29C (50.86 mm) (Table 5).

Table. 5. Average diameter in the Bi-Baum system, 2.0 m (mm) (2021-2022)

Variant	2021	2022
Congat	43.02c	43.55c
Delice	52.33a	49.92a
Flopria	43.29c	42.24c
Lady Cot	47.95b	50.86a
Lido	37.07d	45.676b
Lilly Cot	48.04b	39.79d
Medflo	46.26b	47.29b
Mikado	0	46.32b
Milord	46.59b	46.83b
Swired	42.46c	42.46c
Wonder Cot	48.00b	43.02c
Average	45.50bc	45.27b

Absorbance difference index (IAD)

In 2021, the IAD values at the time of the analysis were between 0.11 and 0.56; in 2022, they were between 0.05 and 0.27. In the analysis of this index in different apricot cultivars, it was found that Delice/M29C, Lady Cot/M29C, Lilly Cot/M29C, Medflo/M29C, and Wonder Cot/M29C had similar values in the first year compared to other cultivars.

The value of this index was the lowest in the cultivars Flopria/M29C, Lido/M29C, and Milord/M29C in the first year. In the second year, the highest value of this index was observed in the cultivar Milord/M29C, the lowest at Flopria/M29C and Lido/M29C (Table 6). The ADI values reflect the fruits' ripening degree, respectively, a comparative scale between cultivars.

Table 6. IAD in different cultivars at the analyses moment (2021-2022)

Variant	2021	2022
Congat	0.28b	0.21b
Delice	0.53a	0.17bc
Flopria	0.15c	0.07ef
Lady Cot	0.56a	0.15cd
Lido	0.36ab	0.04f
Lilly Cot	0.55a	0.09ef
Medflo	0.55a	0.12de
Mikado	0	0.07ef
Milord	0.10c	0.27a
Swired	0.20bc	0.20bc
Wonder Cot	0.47a	0.06f
Average	0.38	0.13cd

Weight pulp

According to the research results, it was found that the highest value was observed and recorded in the first year in the cultivar Delice/M29C (80.57 g) and the second year at the cultivar Lady Cot/M29C (77.84 g). The values varied in 2021 between 27.69 and 80.57 g and 2022 between 37.55 and 77.84 g.

Kernel weight

In the study of the differences in kernel weight in different cultivars in the Bi-Baum planting system, 2.0 m, it was found that in the first year, the cultivars Congat/M29C and Wonder Cot/M29C had the highest values. The other varieties had lower values and no significant differences between them in the first year of the study. In the second year of the study, it was found that the cultivars Delice/M29C, Lady Cot/M29C, and Milorod/M29C had the highest kernel weight compared to other cultivars studied. Values ranged between 1.89 g (Lilly Cot/M29C) and 3.90 g (Delice/M29C) in 2021, respectively between 2.01 g (Wonder Cot/M29C) and 4.01 g (Lady Cot/M29C) in 2022.

Total soluble solids content

In the analysis of the content of total soluble solids (TSS) content in different cultivars, it was found that in the first year, the TSS amount was significantly higher in the cultivars Congat/M29C and Delice/M29C compared to other cultivars. In the second year of research, the highest TSS amount was observed and recorded in the cultivar Congat/M29C (Table 7). The values were between 7.21 and 12.52 °Brix in 2021, respectively between 8.13 and 16.91 Brix in 2022.

Table 7. Total soluble solids content in different cultivars in the Bi-Baum system, 2.0 m (°Brix) (2021-2022)

Variant	2021	2022
Congat	12.52a	16.91a
Delice	11.89a	10.84c
Flopria	7.60de	9.25def
Lady Cot	8.92bcd	10.86c
Lido	7.21e	10.35cd
Lilly Cot	7.49de	8.13f
Medflo	7.49de	9.36def
Mikado	0	8.61ef
Milord	11.89b	13.57b
Swired	9.74bc	9.74cde
Wonder Cot	8.60cde	8.79ef
Average	9.17bc	10.58cd

Total acidity

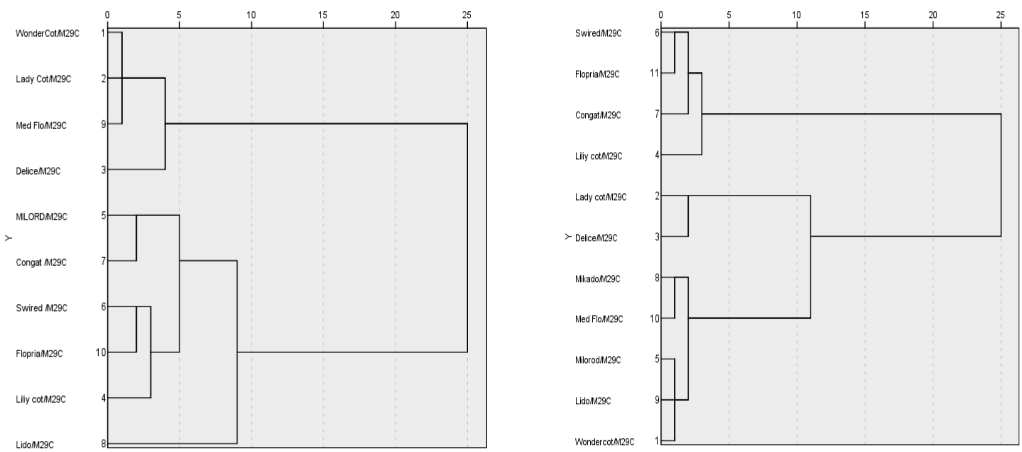
The highest value was observed in cultivars Lido/M29C and Lilly Cot/M29C in the first year of research, respectively, in the cultivar Lady Cot/M29C for the second year. Congat/M29C presented the lowest value in both years compared to other cultivars. Values ranged between (Congat /M29C) 1.05 g acid malic/100 g fw and (Lilly Cot/M29C) 1.97 g acid malic/100 g fw in 2021, respectively between (Congat/M29C) 0.72 g acid malic/100 g fw and (Lady Cot/M29C) 2.08 g acid malic/100 g fw) in 2022.

Soluble dry matter

The content values ranged between 7.20% (Lido/M29C) and 12.50% (Congat /M29C) in 2021, respectively between 8.51% (Wonder Cot/M29C) and 17.00% (Congat/M29C) in 2022. The highest value of this index was observed and recorded in the cultivar Congat/M29C in both years of study. In addition, the Swired cultivar had a similar value in the second year.

Cluster analyze

The cluster analysis found that the cultivars were divided into several groups in the first year. The similarities were between Wonder Cot/M29C and Medflo/M29C, Lady Cot/M29C, Delice/M29C, Swired/M29C, and Lilly Cot/M29C (Figure 2).



2021 2022

Figure 2. Custer analyzes different cultivars in Bi-Baum, 2.0 m

The series of cultivars grown in the Bi-Baum system, 1.5 m per row

Fruit Length

The results related to the length of the fruits showed that in the first year of the study, maximum values were observed in the fruits of the variety Pisana/M29C (59.42 mm), followed by cultivars Vitillo/M29C (54.99 mm) and Primaya/SJA (53.63 mm). In the second year of the study, the most extended fruit length was observed in the cultivar Vitillo/M29C (57.84 mm), followed by Primaya/SJA (53.39 mm). The most petite fruit length was recorded in the cultivars Congat/GF677 in both years of study (42.45 mm in 2021, 38.68 mm in 2022).

Average fruit diameter

In the examination of the average diameter of the fruits, it was found that, in the first year, the values varied from 41.08 mm (Boccuccia Liscia/M29C) to 53.88 mm (Pisana/M29C). In the second year, the values ranged between 36.73 mm (Congat/GF677) and 55.37 mm (Vitillo/M29C).

Absorption difference index (IAD)

The values of the absorption difference index varied between 0.08 (Boccuccia Liscia/M29C) and 0.39 (Rubista/M29C) in 2021, respectively between 0.05 (Boccuccia Liscia/M29C) and 0.41 (Congat/M29C) in 2022, indicating the level of ripening of the fruit (Table 8).

Table 8. IAD in different cultivars in the Bi-Baum system, 1.5 m (2021-2022)

Variant	2021	2022
Bergeron/M29C	0.17bc	0.09cde
BoccucciaLiscia/M29C	0.08d	0.05e
CMBU/M29C	0.27b	0.16bc
Congat/GF677	0.13cd	0.41a
Pisana/M29C	0.23bc	0.18b
Portici/M29C	0.18bc	0.09de
Primando/SJA	0	0.12bcd
Primaya/SJA	0.23bc	0.13bcd
Rubista/M29C	0.39a	0.14bcd
Vitillo/M29C	0.15cd	0.13bcd
Average	0.20bc	0.15bcd

Weight pulp

The research results showed that the cultivars studied showed significant differences in pulp weight in both years studied. The highest value in the first year was observed at Pisana/M29C (81.85 g), followed by Congat/GF677 (77.98 g), Primaya/SJA (70.08 g), and Vitilo/M29C (73.46 g). Cultivars Boccuccia Liscia/M29C (40.78 g) and Rubista/M29C (20.41 g) had the lowest pulp weight in the first year of the study. In the second year of the study, the highest pulp weight was observed in Vitillo/M29C (93.35 g), followed by Primaya/SJA (81.09 g).

It should be noted that pulp weight in other cultivars studied in the second year was generally less than 50 g.

The **kernel weight** results at the plants in the Bi-Baum system, 1.5 m per row, showed that the cultivar Vitillo/M29C had the highest kernel weight in both years compared to the other cultivars. Kernel weight in this cultivar was four times greater in the second year compared to cultivars Primando/SJA and Rubista/M29C, which had the lowest values. This year, the kernel weight of other cultivars was less than 4 g.

Total soluble solids content

Analyzing the content in total soluble solids (TSS), it was found that in the studied years, the cultivars Boccuccia Liscia/M29C and Congat/GF677 had the highest values compared to other cultivars. Pisana/M29C and Primaya/SJA showed the lowest values in 2021, and Primando/SJA, Primaya/SJA, and Vitlilo/M29C in 2022 (Table 31). Values ranged between 7.13 °Brix and 15.47 °Brix in 2021, respectively between 8.50 °Brix and 17.69 °Brix in 2022.

Total acidity

The titratable acidity measurement showed that the highest value was observed in the cultivar Rubista/M29C, followed by Primaya/SJA in the first year. In the second year of the study, it was also found that the titratable acidity of the cultivar Primando/SJA was significantly higher than other cultivars studied.

Dry matter content

Data related to the total dry matter in the first year of the study showed that the cultivars Boccuccia Liscia/M29C, Congat/GF677, and Primaya/SJA showed higher values than other varieties. The lowest value was observed at CMBU/M29C in the first year. In the second year, the values increased in most of the varieties studied compared to the first year. In the second year, the highest total dry matter was recorded in the cultivar Congat/GF677 (17.01%).

Cluster analysis

Cluster analysis of cultivars showed that apricot cultivars were generally placed in two groups according to the traits studied in the two years. Cultivars Portici/M29C, CMBU/M29C, Bergeron/M29C, Bocuccio/M29C, Pisana/M29C, and Vitilo/M29C were classified in a single group, and the cultivars Congat/GF677, Primaya/SJA, and Rubista/M29C were classified in another separate group (Figure 3). Note the similar profiles for the following cultivars: Portici/M29C, CMBU/M29C, Bergeron/M29C, and Pisana/M29C; Boccuccia Liscia/M29C and Vitillo/M29C; Congat/GF677and Primaya/SJA.

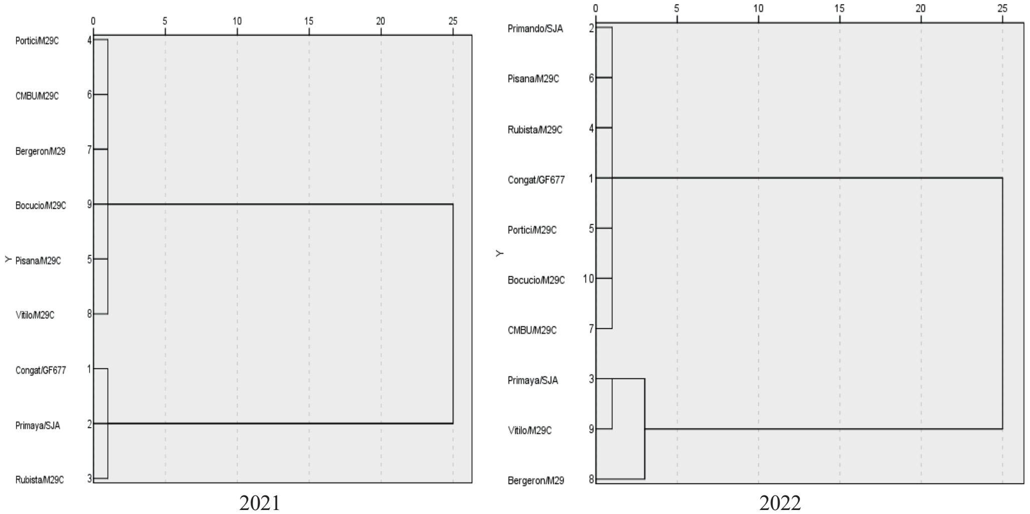


Figure 3. Cluster analysis in different cultivars in the Bi-Baum system, 1.5 m

The Influence of rootstock or canopy shape on fruit quality parameters

Comparing the quality parameters to the cultivar Primaya/SJA in the two planting systems, Trident and Bi-Baum, significant differences were observed between the parameters, as with the Congat cultivar on two different rootstocks (M29C, GF677) in the planting system, Bi-Baum.

Discussion

The research results showed that the different cultivars in the study, depending on the rootstock and canopy shape, responded differently to the indices studied in the evaluation. The difference between the studied parameters comes from the differences between the cultivars, the planting system, and the climatic and geographical conditions of the place where the plants are grown (Pfeiffer & Hegedus, 2011).

Fruit quality parameters have always been important in trade. The quality of the fruit is correlated with the balance between sugar and acid content and its unique flavor (Molaie et al., 2016).

The high amount of sugar and the low amount of organic acids in the fruit cause a sweet taste (Akin et al., 2008). In addition, firmness and fruit size are two important and influential factors in the increase in economic value and fruit sales (Rousos et al., 2011). The color of apricot fruit is affected by flavonoid glucosides. It should be noted that the synthesis of these compounds in the plant is influenced by sunlight. Therefore, environmental factors such as light and temperature play an essential role in apricot fruit coloring (Pfeiffer & Hegedus, 2011).

This issue can effectively choose the right canopy shape of the plant. Jannatizadeh et al. (2010) studied 39 cultivars and genotypes of Iranian apricots using morphological traits; their results showed that the coefficient of variation of the ratio of total soluble solids (TSS) to titratable acidity (TA), kernel weight, fruit flesh weight, and fruit weight had high values, which indicate the possibility of selection for improvement and modification in breeding programs.

Mohhamadzadeh et al. (2005) evaluated 21 pomological and morphological traits in research to compare, group, and select the superior genotypes from 32 native apricot cultivars and genotypes.

The results showed large variations between cultivars, and significant positive and negative correlations were observed between some of their traits. Primaya/SJA had greater fruit length, average fruit diameter, kernel length, pulp weight, total titratable acidity, and total titratable acidity/TSS ratio than other cultivars. However, the TSS and glucose content were the lowest compared to other cultivars.

Cultivar Anegat/M29C also had higher fruit and kernel lengths than other apricot cultivars.

This study showed that the Farbali cultivar grafted on M29C and SJA also showed acceptable performance about fruit-related indicators. The study of different cultivars grafted on M29C in the Bi-Baum system, 2.0 m per row, showed that the cultivar significantly affects the biochemical traits of the fruit. Delice, Wonder Cot, and Congat varieties showed acceptable results among the studied cultivars.

In examining cultivars in the Bi-Baum system (1.5 m on the raw), it was also found that Primaya/SJA, even in this system, showed good performance in traits related to the plant's fruit. This issue shows the importance of choosing the proper cultivar more than before. According to the purpose of cultivation of the apricot cultivars (fresh, dried, and processed consumption), selecting suitable cultivars from the studied cultivars is possible.

CONCLUSIONS

It can be explained that the different cultivars studied in the research have shown different behaviors about the indicators related to the fruit. In some cases, regardless of the shape of the canopy, the cultivated cultivar has provided appropriate responses.

This issue indicates the great importance of a suitable cultivar during cultivation. In addition, choosing the suitable rootstock in the plant is also an essential and influential factor in the plant's growth. Therefore, it can be explained that choosing the suitable rootstock and cultivar according to the ecological conditions of the region has, in some cases, resulted in producing a good quality product that can compete with native cultivars that are sometimes susceptible to certain diseases or biological stress.

ACKNOWLEDGEMENTS

The authors want to thank all their colleagues, students, researchers, management, and staff at Horticulture College, University of Agronomic Sciences and Veterinary Medicine of Bucharest, for their assistance in this research activity.

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