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THE STUDY OF SOME APPLE GENOTYPES WITH RESISTANCE TO DISEASES CANDIDATE FOR OBTAINING NEW VARIETIES

Gavrilă Marian-Florin[1,2]*; Petre Gheorghe[1], Comănescu Daniel[1]
[1] Voinesti Research and Development Station for Fruit Growing, Voinesti
[1,2]Doctoral School of Plant and Animal Resources Engineering, Faculty of Horticulture, University of Craiova, 13 A.I. Cuza Street, 200585, Craiova, Romania
* *Correspondence author. E-mail*: gavrila_marian1@yahoo.com

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ABSTRACT

The researches performed at Voineşti Research and Development Station for Fruit Growing in the apple breeding program for obtaining varieties with resistance to diseases highlights the biological characteristics of some existing genotypes in the competition microculture established in 2019. In the 11 apple genotypes taken in the study, compared to the 'Florina' variety taken as a reference, it is analysed the evolution of the flowering phenophases, the period of fruit ripening and storage, as well as the quality determined by biomass, dry matter content and firmness of the pulp during 2022-2024. Some of the apple genotypes in the competition microculture meet the requirements imposed for the approval of new varieties with resistance to diseases, which can meet the market requirements and the expansion in modern orchards from the established orchards. From the recording of the flowering phenophases, it is noted that they are advanced by about two weeks in the year 2024, compared to the years 2022 - 2023, due to the increase in temperatures in March, against a background of sufficient moisture, being a signal for the study of phenology in the face of climate change. The apple genotypes with disease resistance present fruits intended for fresh consumption, most with winter ripening, with a compact, consistent firmness and an appreciable dry matter content, characteristics that promote them for the approval of new varieties. Three of the apple genotypes were registered for homologation, one becoming the 'George' variety, being appropriate to the demands of the producer, sensitive to economic efficiency, with quality fruits, which will certainly meet the ever-increasing consumer demands.

INTRODUCTION

Obtaining new varieties with improved properties and characteristics is a permanent requirement of both growers and fruit consumers. This is also the main objective of genetic improvement and controlled or natural selection that have taken place over time (Branişte, 2004; Cociu et al., 1999). From the hybridisations carried out in the breeding laboratory from Voineşti Research and Development Station for Fruit Growing apple genotypes were selected, which correspond to the requirements for the approval of new varieties with resistance to diseases, contributing to a great extent to change the concept of growers and the gradual change of the assortment (Petre et al., 2017, 2019, 2020). There are several apple cultivars that have been developed to be resistant to common diseases such as turnip (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*). These genotypes were obtained through genetic selection and breeding to reduce the need for chemical treatments

and increase productivity under less favorable conditions (Peil et al., 2021). The selection of genotypes from the competition microculture and the approval of new varieties of apple with resistance to diseases, constitute for the new plantations, links of high-performance economic technology, with immediate effect for the total or partial elimination of treatments with fungicides (Petre & Petre, 2014; Gavrilă & Petre, 2022). By promoting disease-resistant apple varieties in culture, the importance given to apple culture at the local and national level is noted, representing the main factor in obtaining less polluted fruits. The purpose of this work was the study of some apple genotypes with disease resistance candidate for obtaining a new variety. These genotypes are ideal for orchards using organic farming techniques or for those wishing to minimize the use of fungicides. Disease resistance is a crucial aspect in choosing the right variety for a particular region, as it contributes significantly to the success and productivity of the orchard.

MATERIAL AND METHODS

The research was organized between 2022 and 2024, in a contest microculture established in 2019, with 11 disease-resistant apple genotypes being studied, compared to the 'Florina' variety taken as a reference. 'Florina' - It is a variety known for its excellent resistance to rot and powdery mildew. It has red, crisp and juicy fruits with a slightly acidic taste. It is widely cultivated in Europe. Trees are grafted onto M9 rootstock, planted at 2.5 x 1 m spacing (4000 trees/ha), crown shape formed loosely flattened. During the research, the development of flowering phenology was followed, depending on the evolution of climatic conditions and the expression of quality, the period of ripening and the duration of keeping the fruits. The flowering phenology was established by recording the calendar dates regarding the appearance of the first open flowers and the end of flowering. Based on these data, the duration of flowering was determined, simultaneously with the establishment of its intensity, being rated with notes on the scale from 1 to 5. The quality of the fruits was highlighted by their biomass, expressed in grams, the firmness of the pulp in Kgf/cm^2 and the dry matter content expressed in percentages. In the contest microculture, the soil was kept clean of weeds in the row of trees and cultivated at intervals, the grass being mechanically mowed 2-3 times, the resulting vegetable mass remaining in the form of mulch. No treatments were applied for diseases, but for pest control 6-8 treatments were applied only with insecticides.

RESULTS AND DISCUSSIONS

The natural framework appropriate for the cultivation of trees, in established areas, the tradition and the need to use the land more intensively, for the production of fruits in large qualitative batches create the premises for the development of a modern fruit culture in Romania. The almost total elimination of fungicidal products and the use of insecticides with a high degree of selectivity, correlated with the quality and productivity of the apple genotypes proposed for the approval of new varieties, justifiably support the economic and environmental protection effects, being the basic arguments in their promotion in culture (Khan & Korban, 2022). The results of the research pertaining to the 11 apple genotypes, candidates for obtaining new varieties, with the observations and determinations regarding the unfolding of the flowering phenophases and the fruit quality parameters, the ripening period and the duration of storage, are presented below.

Table 1

Evolution of flowering phenophases in selected apple genotypes (2022-2024)

Crt no.	Genotype	Years 2022 - 2023				Year 2024			
		The start and end of flowering (no of days)		Duration of flowering (days)	The intensity of flowering	The start and end of flowering (no of days)		Duration of flowering (days)	The intensity of flowering
		Start	End			Start	End		
1	H 18/6	113-115	126 - 127	13	4 - 5	98	107	10	4
2	H 19/6	114 - 116	127 -128	13-14	4 - 5	99	106	8	4
3	H 8/1	111 - 113	124 - 126	14	4	97	105	9	4
4	H 4/17	114 - 115	125 - 126	12	4 - 5	97	106	10	4
5	H 1/28	115 - 117	124 - 127	10-11	4 - 5	99	107	8	4
6	H 2/3	111 - 113	122 - 123	11	5	96	106	11	5
7	H 4/44	112 - 115	126 - 127	11 - 13	4	97	106	10	3
8	H 4/42	111 - 113	122 - 123	11 - 12	4	96	106	11	3
9	H 14/1	113 - 115	124 - 126	12	4	96	106	11	3
10	H 1/55	115 - 117	125 - 127	11	4 - 5	98	107	10	4
11	H 8/6	114 - 116	125 - 126	11 - 12	3 - 4	99	108	10	3
12	'Florina' (Mt)	115 - 119	127 - 130	12 - 13	4 - 5	100	108	9	5

Table 2

Fruit biomass of apple genotypes from the competition microculture (2022-2024)

Crt no	Genotype	Average fruit weight (g)			
		2022	2023	2024	Media
1	H 18/6	175	150	150	158
2	H 19/6	160	165	160	162
3	H 8/1	190	220	165	191
4	H 4/17	160	150	170	160
5	H 1/28	175	155	160	163
6	H 2/3	170	180	170	173
7	H 4/44	150	155	150	152
8	H 4/42	160	180	170	170
9	H 14/1	160	170	165	165
10	H 1/55	190	190	200	193
11	H 8/6	175	180	160	171
12	'Florina' (Mt)	175	180	185	180

The course of the flowering phenophases

In order to evaluate the pace of flowering phenophases, the number of days passed from the beginning of the year to the calendar dates, which marked the beginning and end of flowering, its duration and intensity, was recorded for the 11 apple genotypes selected according to the criterion of resistance to the attack of the main diseases and the variety 'Florina' widespread in the culture, taken as a reference (Table 1). In 2022 – 2023 the entire evolution process of the phenophases of the fruit buds, moving from the swelling phase, leafing, to those of spreading, pink button or the first open flowers, took place within close limits, with differences of two to three days, in the 2 years of study.

The opening of the first flowers in the apple genotypes taken in the study and the 'Florina' variety taken as a reference took place from the last decade of April, with a number of 111-117 days, calculated from the beginning of the year. From the recorded data, it can be seen that the first flowers opened on the genotypes H 8/1, H 2/3 and H 4/42, and the last were the genotypes H 18/6, H 4/17, H 4/44, H 14/1, H 19/6, H 8/6 and H 1/28, with 115 days. The end of flowering recorded in the first decade of May, with a number of 122-128 days, determined a duration of flowering of 11-14 days. The intensity of flowering was evaluated with grades of 4 and 5 (on a scale of 0-5), the degree of flowering ensured adequate productions for all genotypes. In 2024, the evolution of climatic conditions was different from the previous years (2022-2023), especially in March, when the maximum daily temperatures frequently exceeded 16-17°C, reaching over 21°C in the last decade, which favoured the rapid passage of the vegetative phenophases of apple fruit buds. The maximum daily temperatures still maintained above 20°C favoured the rapid development of the fruit bud phenophases in apple, reaching the early varieties in the leafing phase, even pink button. After the date of 05.04.2024, the maximum daily temperatures were above 20°C, reaching between 09-12.04.2024 and further maximum daily temperatures of 23-26°C, accelerating the flowering phase of the apple genotypes studied. Therefore, in the apple genotypes from the contest microculture, the first flowers opened from the first decade of April, after 96-99 days recorded from the beginning of the year and 100 days in the 'Florina' variety taken as a reference. From the recorded data, it can be seen that, in 2024, the evolution of climatic conditions favoured the initiation of flowering in the apple genotypes from the contest microculture about 2 weeks earlier compared to the years 2022 and 2023. Due to the maximum daily temperatures of 23 - 26°C, recorded in the first decade of April and further, they determined a duration of flowering of 8-11 days, its end being completed already in the second decade of April, at 106 - 108 days from the beginning of the year, including the 'Florina' variety taken as a witness. The intensity of flowering with grades of 3, 4 and 5 designates the most productive apple genotypes, respectively H 2/3 graded with 5 and the majority with grades of 4. In the year 2024, there is an advance in the initiation of flowering in the apple genotypes studied, due to climate changes, the earlier start may suggest a selection of genotypes, adopting phenology in response to temperature fluctuations and the evolution of meteorological conditions. Synchronization of flowering in the apple genotypes under study ensures efficient pollination and optimal fruit production. The recorded observations underline the importance of continuous and detailed monitoring of

flowering phenophases in order to develop effective strategies for the promotion in culture of new varieties approved according to adaptation to climate change.

Quality parameters of apples

Apples intended for fresh consumption or for processing must be healthy, reach commercial or consumption maturity and have organoleptic properties specific to the variety. To be marketed, apples must meet market standards and maintain their quality, both after harvest and during storage and delivery (Branişte et al. 2004).

The quality of the fruits is of a genetic nature, being influenced by the variety, the degree of ripening, the action of environmental factors, as well as technological factors. Average weight and size are important elements in assessing the commercial quality of fruit. The study undertaken on apple genotypes with resistance to diseases, reveals a genetic variability regarding the size of the fruits (Table 2). During the study period (2022-2024), the fruit biomass of the apple genotypes from the contest microculture fluctuated from year to year, being within the limits of 150 to 220 g/fruit. The average weight over the 3 years of study places the apple genotypes in 2 size groups:

- medium-sized fruits, with 152-165 g/fruit: H 18/6, H 4/17, H 19/6, H 1/28, H 14/1;
- large fruits with over 170 g/fruit: H 4/42, H 8/6, H 2/3, H 8/1, H 1/55 and the 'Florina' variety taken as a reference, with 180g/fruit.

Analysing the fruit quality parameters of the genotypes from the competition microculture, in the period 2022 - 2024, represented by the firmness of the pulp and the dry matter content, have different values depending on the type (Table 3).

Table 3

Pulp firmness and dry matter content in apple genotypes from the competition microculture (2022-2024)

Crt no	Genotype	Firmness of the flesh (kgf/cm^2)				The dry substance (%)			
		2022	2023	2024	Average	2022	2023	2024	Average
1	H 18/6	10,6	11,6	11,2	11,1	13,3	11,7	14,3	13,1
2	H 19/6	10,4	12,6	12,3	11,7	13,1	12,8	15,8	13,9
3	H 8/1	10,3	9,1	11,8	10,4	13,2	14,2	15,4	14,2
4	H 4/17	10,6	12,6	12,5	11,9	12,5	11,6	14,2	12,8
5	H 1/28	11,7	12,6	12,0	12,1	15,6	11,3	13,3	13,4
6	H 2/3	12,0	12,1	9,9	11,3	12,1	13,0	13,3	12,8
7	H 4/44	10,9	10,5	12,3	11,2	13,5	13,6	16,2	14,5
8	H 4/42	10,1	10,4	12,3	11,0	12,8	13,1	15,5	13,8
9	H 14/1	9,9	9,0	12,3	10,4	13,6	14,5	15,7	14,6
10	H 1/55	9,5	10,8	8,9	9,8	13,2	12,3	13,2	12,9
11	H 8/6	10,6	10,6	12,4	11,2	13,3	14,2	15,4	14,3
12	'Florina' (Mt)	11,6	11,4	11,2	11,4	14,0	14,0	13,9	14.0

The firmness of the fruit pulp is considered appropriate when it is compact, crisp or fine, with a uniform colour. A low (flourish) firmness is considered unsatisfactory and is generally found in overripe fruit. Also, a hard, coarse constitution with areas of glassiness is negatively appreciated. In the conditions of the years 2022 - 2024, the firmness of the fruit pulp at harvest recorded values between 8.9 and 12.5 kgf/cm^2, with an average over the 3 years of study of 9.7 kgf/cm^2, for the genotype H 1/ 55 and 12.1 kgf/cm^2 at genotype H 1/28. Most apple genotypes have a compact, consistent firmness with average values over 10 kgf/cm^2

and in the 'Florina' variety 11.4 kgf/cm^2. The dry matter content of the disease-resistant apple genotypes remained between 11.7 and 15.7%, with average values of 12.8% at H 4/17 and 14.6% at H 14/ 1.

The period of ripening and the duration of fruit storage

The assortment of apple varieties, including disease-resistant apple varieties, must ensure fruit for fresh consumption for as long as possible (Branişte et al. 2004). One of the important features that is taken into account in the apple genotypes in the microculture competition, is the analysis of the ripening period and the ability to keep the fruits. The duration of fruit storage benefits the producer, who has the opportunity to offer fruit on the market in the cold season, extending the consumption period when there are no more fruits in the orchard. The 11 apple genotypes with resistance to diseases, from the competition microculture, have different consumption times, the ripening period starting from the last decade of August, until the first decade of October (Table 4).

Table 4

The period of ripening and the time of fruit consumption for the apple genotypes taken in the study

Crt no	Genotype	Fruit ripening period	Consumption period	Fruit storage time (days)
1	H 18/6	25-30.09	September - February	129-134
2	H 19/6	01-10.10	October - March	145-150
3	H 8/1	15-20.09	September - January	108-113
4	H 4/17	01-10.10	October - March	145-150
5	H 1/28	15-20.09	September - December	106 - 111
6	H 2/3	20-25.09	September - December	101 -106
7	H 4/44	20-25.09	September - December	101 -106
8	H 4/42	20-25.09	September - January	108-113
9	H 14/1	20-25.09	September - January	108-113
10	H 1/55	25-30.08	August - September	20 - 30
11	H 8/6	20-25.09	September - January	108-113
12	'Florina' (Mt)	25-30.09	October - March	145 - 150

Depending on the ripening and storage period of the fruits, the apple genotypes with resistance to diseases, taken in the study, are grouped as follows:
- summer ripening genotypes: H 1/55;
- autumn ripening genotypes: H 1/28, H 2/3, H 4/44;
- winter ripening genotypes: H 18/6, H 19/6, H 8/1, H 4/17, H 4/42, H 14/1, H 8/6.

The apple genotypes cultivated in the competition microculture, taken in the study, occupy a large part of the consumption season, but not all of them present characteristics to become new varieties, to be grown alongside disease-resistant apple varieties appreciated by consumers on the market. So far, the following genotypes have been registered at ISTIS for testing with the purpose of approval: H 4/17; H 2/3 and H19/6. In 2024, the H 4/17-04 genotype was approved as 'George' apple variety.

CONCLUSIONS

1. The research highlights a database specific to the behaviour in the competition microculture of 11 disease-resistant apple genotypes, being in the final phase of transition for approval and integration into commercial orchards.

2. Monitoring the flowering phenophases over three years of study, highlights their advance by approximately two weeks in 2024, compared to 2022-2023, adapting phenology to the challenges of climate change.

3. Some of the apple genotypes with disease resistance, taken in the study, have fruits intended for fresh consumption weighing more than 170 g, main characteristics for approval proposals.

4. Most of the apple genotypes are winter-ripening, with a compact, consistent firmness, with average values over 10 kgf/cm^2 and an appreciable dry matter content for increasing fruit quality.

5. The apple genotypes from the competition microculture, registered at ISTIS for approval of new varieties with resistance to diseases, meet the market requirements to be promoted in modern commercial orchards, representing the main factor in the production of less polluted fruits, with a positive effect in protecting the environment and a long-term economic viability.

a) H 2/3-04

b) H 19/6 -04

Figure 1. Apple genotypes

Figure 2. Genotype H 4/17-04 ('George')

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