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APPLE VARIETIES WITH DISEASE RESISTANCE, OBTAINED AT THE RESEARCH AND DEVELOPMENT STATION FOR FRUIT GROWING VOINEŞTI IN THE PERIOD 2016-2025

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ABSTRACT

The research carried out at the Research and Development Station for Fruit Growing (SCDP) Voinești aimed to evaluate the main agrobiological and technological characteristics of the seven apple varieties with genetic resistance to diseases, approved in the period 2016–2025, in order to highlight their value for the diversification of the assortment and promotion in commercial plantations. The evaluation of the growth vigor in the seventh year after planting, in the trees grafted on the M9 rootstock, highlighted differences between the studied varieties, the trunk diameter varying between 39.5 mm, in the 'Carpathian' variety, and 48.8 mm, in the 'George' variety. At the density of 2,857 trees/ha, the volume of crowns in relation to the unit of area recorded values between 5,150 m³/ha, for the 'Carpatin' variety, characterized by low to medium vigor, and 8,550 m³/ha, for the 'Valery' variety, with higher growth vigor. During the period of full fruiting, the productive potential of the varieties cultivated in a high-density system varied between 28 and 45 t/ha, the highest yields, of over 35 t/ha, being obtained for the varieties 'George', 'Dâmbovițean', 'Valery', 'Brumar' and 'Cezar'. The average fruit mass was between 160 and 190 g, lower values being recorded for the 'Revidar' variety, while the varieties 'Cezar', 'Valery', 'Carpatin' and 'Brumar' stood out for fruits with an average mass of over 175 g. The results highlight the productive and qualitative potential of the analyzed varieties, as well as the opportunity to introduce them into commercial plantations. The diversity of agrobiological properties and resistance to diseases recommend these creations to complete the apple assortment and develop economically efficient cultivation systems with low environmental impact.

INTRODUCTION

The genetic improvement of the apple (*Malus domestica* Borkh.) aims to obtain varieties that associate high productivity, superior fruit quality and resistance to the main pathogens. Among the apple diseases, apple scab, produced by *Venturia inaequalis* (Cooke) G. Winter, is one of the most important limiting factors of production, requiring the application of repeated phytosanitary treatments to susceptible varieties (Gessler et al., 2006; Gessler and Pertot, 2012). Research on the genetic determinism of resistance to apple scab has highlighted the existence of major resistance genes (Rvi) and loci with quantitative effect (QTL), exploited in breeding programs through hybridization and selection (Liebhard et al., 2003; Calenge et al., 2004; Bus et al., 2011). Overcoming the resistance conferred by certain major genes,

as a result of pathogen variability, has led to the orientation of research towards the diversification of genetic sources and the pyramiding of resistance genes (Patocchi et al., 2004; Lasserre-Zuber et al., 2018; Patocchi et al., 2020).

In Romania, the Voinești Fruit Growing Research and Development Station has made an important contribution to the creation and promotion of apple varieties with genetic resistance to diseases. The research carried out has highlighted the agrobiological and technological value of some native varieties, characterized by disease resistance, productivity and qualitative qualities corresponding to market requirements (Gavrilă et al., 2023). At the same time, studies on the cultivation technologies of resistant varieties have contributed to the foundation of economically efficient production systems (Petre et al., 2009, 2014, 2019, 2020). Within the genetic improvement programs of the apple, obtaining varieties with resistance to diseases must be correlated with the improvement of the qualitative characteristics of the fruits and the storage capacity.

Recent research has highlighted the importance of identifying genes associated with ethylene biosynthesis, involved in fruit ripening and senescence processes (Iancu et al., 2025), as well as the influence of parental forms on pulp firmness and storage capacity of new genotypes (Iancu et al., 2026). In addition, the characterization of the biochemical profile and antioxidant activity of fresh apple fruits contributes to highlighting the nutritional value and qualitative particularities of the studied genetic material (Gavrilă et al., 2025). The integration of these criteria in the selection process allows the identification of genotypes that associate disease resistance with productivity, superior fruit quality and fitness for storage, objectives also pursued within the breeding program carried out at SCDP Voinești. The objective of the work is to characterize the apple varieties with resistance to diseases, obtained in the period 2016-2025, in terms of the main agrobiological properties, behavior towards pathogens and quality of the fruits, in order to highlight their value for the diversification of the assortment and the development of a sustainable fruit growing.

MATERIAL AND METHODS

The biological material used in the research was represented by the apple varieties with resistance to diseases, obtained and approved between 2016 and 2025 at the Research and Development Station for Fruit Growing (SCDP) Voinești. Their creation and selection were achieved by capitalizing on the existing genetic fund within the station, consisting of the biological material in the selection fields, the hybrid nursery and the comparative competition microcultures. The selected genotypes were evaluated in order to identify those that associate disease resistance with a high productive potential and superior qualitative characteristics of the fruits.

In order to highlight the peculiarities of growth and fruiting, the studied varieties were evaluated under intensive cultivation conditions, the trees being grafted on the low-vigor rootstock M9 and planted at distances of 3.5 × 1.0 m, corresponding to a density of 2,857 trees/ha. The management system used was the spindle, adapted to the growth and fruiting peculiarities of the analyzed varieties. During the study period, biometric observations and determinations were made regarding the increase in trunk thickness and crown dimensions, in order to characterize the growth vigor of the trees. The fruiting potential was evaluated by recording the fruit production, and the assessment of their quality was made based on the determination of the average fruit mass and the dry matter content. The data

obtained were used for the comparative characterization of the varieties and to highlight their agrobiological and technological particularities.

RESULTS AND DISCUSSIONS

Obtaining new apple varieties is a long-term and highly complex genetic breeding process, especially when the main objective is to associate genetic resistance to diseases with superior agrobiological and technological characteristics, regardless of the breeding methods used. During the 7 years of vegetation, the apple varieties approved at the Research and Development Station for Fruit Growing Voinești showed an appropriate vegetative behavior, bearing fruit starting with the third year after planting. They were characterized by high yields, both quantitatively and qualitatively, resistance to apple scab and partial resistance to powdery mildew. The evaluation of the growth vigor in the seventh year after planting, when the vegetative potential of the trees is well defined, highlighted differences between the apple varieties with resistance to diseases approved in the period 2016–2025, in terms of increase in trunk thickness, tree height and crown sizes (Table 1).

In the seventh year after planting, the trunk diameter of the 7 apple varieties, grafted on the M9 rootstock, recorded values between 39.5 mm for the 'Carpatin' variety and 46.8 mm for the 'George' variety, the other varieties presenting intermediate values between 42.1 and 46.2 mm. The volume of the crown is an important indicator of vegetative development, reflecting the ability of the trees to form the supporting structure of branches, leaves and fruits. In the tenth year after planting, the height of the trees varied between 220 and 280 cm, and the thickness of the fruit fence between 120 and 140 cm. At the planting density of 2,857 trees/ha, the volume of crowns in relation to the unit of area recorded values between 5,150 m^3/ha, for the 'Carpatin' variety, and 9,550 m^3/ha, for the 'Valery' variety, values corresponding to the growth peculiarities and age of the trees. Based on the biometric indicators on the growth vigor, the 'Redix', 'Remar' and 'Valery' varieties were classified in the category of medium vigor varieties, while the 'Cezar', 'Revidar', 'Brumar', 'Carpatin' and 'Dâmbovițean' varieties showed a low-medium vigor.

The development of the fruiting phenophases showed differences between the studied varieties in terms of the beginning and duration of flowering. The earliest flowers were recorded in the 'Brumar' variety, on April 20, followed by the other varieties, in which the beginning of flowering was between April 22–25. The latest varieties were 'George', 'Carpatin' and 'Dâmbovițean', in which the first flowers opened on April 25. The end of flowering was recorded between April 28 and May 8, the duration of this phenophase being between 7 and 14 days, depending on the particularities of the varieties and the evolution of climatic conditions. Overall, the analyzed varieties fell into the group of those with medium flowering, presenting totally or partially overlapping flowering periods, favorable to achieving mutual pollination.

The ripening of the fruits was staggered, depending on the genetic particularities of the varieties. For the 'Revidar' variety, the harvest maturity was recorded between August 25–31, being classified in the group of summer varieties. The 'Cezar' and 'Brumar' varieties showed fruit ripening between September 15–20, being classified in the group of autumn varieties. In the 'Valery' variety, the harvest maturity was between September 25 and October 1, being characterized by winter fruits, with a higher storage capacity. Under the conditions of storing apples in naturally cooled spaces, the duration of fruit storage was 25–35 days for summer varieties, 40–50 days for autumn varieties and 125–150 days for winter varieties.

These differences highlight the possibility of staggering consumption and capitalizing on production over a longer period.

One of the priority objectives of the research was the evaluation of the production capacity, which is an essential criterion in assessing the agrobiological and economic value of the varieties and in promoting them for the establishment of new commercial plantations. The association of a high productive potential with a higher quality of fruits and resistance to diseases highlights the ability of apple varieties to efficiently capitalize on the ecological conditions specific to the cultivation area.

Table 1

Peculiarities of growing and fruiting apple varieties with resistance to diseases, approved by SCDP Voineşti in the period 2016-2025

Special features	Variety and year of approval						
	Valery 2016	*Caesar* 2016	*Revidar* 2007	*Brumar* 2020	*George* 2024	*Carpatin* 2025	*Dâmboviţean* 2025
I. Vigor of tree growth							
Trunk diameter in 7 year after planting	46,2	43,7	43,9	43,9	46,8	39,5	42,1
Height of trees – cm	280	260	260	240	250	200	250
Thickness of the fruit hedge – cm	130	130	130	120	130	120	130
Crown volume (cubic meters/ha)	8.550	7.800	7.800	6.520	7.430	5.150	7.430
II. Particularities of fruiting							
Phenophase of fruiting							
The beginning of flowering	24-29.04	22-28.04	22-28.04	20-26.04	25-26.04	25-27.04	25-27.04
The end of flowering	01-06.05	30.04 - 05.05	30.04-05.05	28.04-03.05	06.07-05	03-04.05	08-09.04
Flowering duration (days)	7-9	7-9	7-9	7-9	10-11	8-9	03-14
Fruit ripening date	25.09-01.10	15-20.09	25-31.08	15-20.09	01-10.10	20-25.09	01-10.10
Consumption time	X-III	X-XII	IX	IX-XI	X-III	IX-XII	X-III
Duration of fruit storage (days)	145-150	80-86	30- 50	45-50	145-150	101-106	145-150
Production (t/ha)	35-40	35-40	28-30	35-40	40-45	38-40	40-45
Production quality							
Fruit biomass (g)	185	190	160	175	170	180	165
Content in SU(%)	16,5	13,8	13,0	13,5	13,8	12,8	13,9

During the period of full fruition, the productive potential of the 7 apple varieties with resistance to diseases, cultivated in a high density system, registered values between 28 and 45 t/ha. The highest yields were obtained for the varieties 'George', 'Dâmbovițean', 'Brumar', 'Valery' and 'Cezar', which achieved productions

of over 35 t/ha, highlighting a superior production capacity in the technological and ecological conditions of cultivation. The quality of the fruits, appreciated by the average mass and the dry matter content, highlighted differences between the analyzed varieties. The average weight of the fruits varied between 160 and 190 g, lower values being recorded for the varieties 'Iris', 'Inedit', 'Voinicel' and 'Revidar', while the varieties 'Cezar', 'Valery', 'Carpatin' and 'Brumar' stood out for their larger fruits, with an average weight of over 175 g. The dry matter content showed values between 13 and 16.5%, reflecting the biochemical particularities of the fruits and the differences between the genotypes studied. In addition to the productive potential and quality characteristics of the fruits, the apple varieties with disease resistance, approved at the Research and Development Station for Fruit Growing Voinești in the period 2004–2020, also have other valuable agrobiological and technological characteristics, which are highlighted below.

The '**George**' **variety** (Fig. 1) is of small-medium vigor, precocious, fruiting on short formations, resistant to rust and powdery mildew. The fruit is conical, yellow in color, weighs an average of 170g, the pulp is crispy, with a very good taste. The harvest maturity in the first decade of October, and the consumption maturity extends until the first of March.



Figure 1. 'George' variety

The '**Carpatin**' **variety** (Fig. 2) is of small-medium vigor, early, fruiting on short and long branches, resistant to rust and powdery mildew. The fruit is red, with brown roughness streaks, with an average weight of 180 g. The maturity for consumption begins in the last decade of September and lasts until December.



Figure 2. 'Carpatin' variety

The '**Dâmboviţean**' **variety** (Fig. 3) is of medium vigor, displayed, fruiting on short and long branches, resistant to rust and powdery mildew. The fruit is dark red, covered 3/4 of the surface, with an average weight of 165 g, crispy pulp with good taste. Maturity for late harvest and consumption until March.



Figure 3. 'Dâmboviţean' variety

The '**Valery**' **variety** (Fig. 4) has the shape of the conical-truncated fruit, yellow-orange on the sunny side, with yellowish-white pulp, crunchy at harvest, with a sweet, very good taste. It is resistant to the attack of *Venturia inaequalis* and weakly attacked by *Podosphaera leocotricha*. It stands out for its precocity, special fruit quality and constant production.



Figure 4. 'Valery' variety

The '**Cezar**' **variety** (Fig. 5) with the shape of the conical-globular fruit, covered with red on almost the entire surface. The pulp is white, sweetly slightly tart, with a very good taste. It is resistant to the attack of *Venturia inaequalis* and *Podosphaera leocotricha*. It stands out for its small-medium vigor, precocity, fruit quality and constant productions.



Figure 5. 'Cezar' variety

The '**Revidar**' **variety** (Fig. 6) with conical fruits, covered with red on 2/3 of the surface. The pulp is white, tangy, juicy with a good taste. It is resistant to the attack of *Venturia inaequalis* and *Podosphaera leocotricha.* It is distinguished by medium – small vigor, precocity, productivity and constant fruiting.



Figure 6. 'Revidar' variety

The '**Brumar**' **variety** (Fig. 7) was approved in 2020. The tree is of medium vigor, very early and productive, it bears fruit on short formations, but also on long annual branches. The flowering is medium, overlapping with most of the apple varieties in the cross-pollination crop. The fruit has an average of over 175 g, is conical, the background color is yellow, and the covering one is red – carmine on 2/3 of the surface. The pulp is yellowish-white, sweetly tangy, juicy, with a very good taste. The maturity for harvesting and consumption begins with the first half of September to November. It is resistant to the attack of the apple scab (*Venturia inaequalis)* and weakly attacked by powdery mildew (*Podosphaera leucotricha*).



Figure 7. 'Brumar' variety

The research carried out at the Research and Development Station for Fruit Growing (SCDP) Voinești has contributed to the diversification of the apple assortment by identifying and promoting varieties with genetic resistance to diseases, characterized by different times of fruit ripening. This diversity allows the staggering of the harvest and the extension of the consumption period, offering growers the possibility of capitalizing on the production over a longer period. In the apple assortment with disease resistance, cultivated and propagated in fruit nurseries in Romania, there are the varieties 'Romus 1', 'Romus 3', 'Romus 4', 'Prima', 'Pionier', 'Voinea', 'Ciprian' and 'Florina'. Although these varieties have valuable characteristics regarding disease resistance, productive potential and fruit quality, the evolution of market requirements and the progress made in genetic improvement require the diversification and continuous updating of the assortment, by introducing new creations, with superior agrobiological and technological performances. The apple varieties with genetic resistance to diseases, obtained at SCDP Voinești, contribute to completing the existing assortment, by diversifying the ripening periods and extending the period of fruit recovery. Their association with the varieties already established and appreciated by consumers can ensure a diversified supply of apples, corresponding to the requirements of commercial production and consumption.

Table 2 shows the new apple varieties with resistance to diseases, approved by SCDP Voinești in the period 2016–2025, as well as their classification in the current assortment, depending on the ripening time and the period of fruit consumption.

Depending on the ripening time and the period of fruit consumption, the apple varieties with resistance to diseases, characterized by high productive potential and superior quality characteristics, occupy distinct positions in the varietal conveyor of the Dâmbovița fruit basin, contributing to the staggering of the harvest and to the extension of the production capitalization period. Thus, after the varieties 'Romus 1', 'Romus 2' and 'Romus 3', the varieties 'Irisem' and 'Real' can be introduced into the varietal conveyor, characterized by fruits with an attractive commercial appearance, whose ripening takes place in the last decade of August and the first decade of September.

Table 2

The consumption period and the classification in the varietal converter of the resistant apple varieties, cultivated in the area of influence of the Research and Development Station for Fruit Growing Voinești

Apple variety	Month																										
	VII			VIII			IX			X			XI			XII			I			II			III		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
'Romus 1' (Vf)		•	•																								
'Romus 2 (Vf)		•	•																								
'Romus 3 (Vf)				•	•																						
'Irisem' (Vf)						•	•																				
'Real' (Vf)						•	•																				
'Revidar' (Vf)						•	•	•	•																		
'Prima' (Vf)						•	•	•	•																		
'Remar' (Vf)								•	•	•	•	•															
'Brumar' (Vf)								•	•	•	•	•															
'Iris' (Vf)								•	•	•	•	•															
'Voinea' (Vf)									•	•	•	•															
'Voinicel' (Vf)									•	•	•	•	•														
'Pionier' (Vf)									•	•	•	•	•	•	•												
'Cezar' (Vf)									•	•	•	•	•	•	•	•	•	•									
'Chindia' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Luca' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Inedit' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Dacian' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Discoprim' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Pomona' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Carpatin' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•						
'Generos' (polygenic)									•	•	•	•	•	•	•	•	•	•	•	•	•	•					
'Redix' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				
'George' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
'Dâmboviţean' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
'Valery' (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
'Florina' (Vf)										•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			

The 'Prima' variety includes the 'Revidar' variety, with a harvesting period between 25 and 31 August and a consumption period that extends until 1 October. The 'Remar' variety occupies an intermediate position between the 'Voinea' and 'Pionier' varieties, presenting favourable prospects for extension in cultivation and gradual replacement of the 'Voinea' variety, due to the superior organoleptic properties and the more attractive colouring of the fruits.

For the autumn period, the 'Brumar', 'Iris' and 'Voinicel' varieties stand out, which can complement the existing assortment together with the 'Pionier' variety, constituting alternatives for its gradual replacement. After the 'Pioneer' variety, the

'Caesar' variety is included in the varietal conveyor, for which the harvest maturity is reached between 15 and 20 September, and the consumption period is extended until the end of December. The varieties 'Chindia', 'Inedit', 'Ciprian', 'Discoprim', 'Pomona', 'Dacian' and 'Carpatin', the latter approved in 2025, show harvest maturity in the last decade of September, the fruits being able to be eaten until the end of December.

The varieties 'Generos' and 'Redix' contribute to extending the consumption period until December-January, completing the assortment intended for recovery in the winter season. The same consumption period as the 'Florina' variety also includes the 'Valery' variety, approved in 2016, characterized by 'Golden Delicious' fruits, with special taste properties. This group is completed by the 'George' variety, approved in 2024, and the 'Dâmbovițean' variety, approved in 2025, which contributes to the diversification of the assortment of apples intended for consumption in the winter period.

The promotion and expansion of disease-resistant apple varieties is an important direction for the modernization of fruit growing, through the possibility of reducing the number of phytosanitary treatments and, implicitly, production costs. At the same time, the use of these varieties is an essential component of integrated and organic production systems, contributing to reducing the impact on the environment and obtaining quality fruits, in accordance with the current market and consumer requirements.

CONCLUSIONS

1. The apple varieties with genetic resistance to diseases, approved at the Research and Development Station for Voinești Fruit Growing in the period 2016–2025, have valuable agrobiological and technological properties, characterized by high productivity, superior fruit quality and adaptability to growing conditions, constituting competitive alternatives for the modernization of the fruit assortment.

2. The evaluation of the peculiarities of vegetative growth highlighted differences between the studied varieties in terms of tree vigor and crown development, confirming the influence of genetic characteristics on their behavior in similar conditions of intensive cultivation.

3. The analyzed varieties showed a high productive potential, associated with favorable quality characteristics of the fruits, highlighting their agronomic value and the prospects for expansion in commercial plantations.

4. The diversity of ripening periods and the fruit storage capacity allows the integration of new creations into the varietal conveyor of the Dâmbovița Fruit Basin, contributing to the staggering of the harvest, extending the consumption period and diversifying the apple supply.

5. The introduction and promotion of varieties with genetic resistance to diseases contributes to reducing the need for phytosanitary treatments and production costs, favoring the application of economically efficient and low environmental impact fruit technologies.

6. The results obtained highlight the contribution of the genetic improvement program carried out at SCDP Voinești to the diversification of the national apple assortment and support the opportunity to continue research to obtain varieties with sustainable resistance to diseases, high productivity and superior fruit quality, adapted to the requirements of sustainable fruit growing.

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