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PROMOTING A METHODOLOGY FOR SHORTENING THE DURATION OF CREATING GENETIC DISEASE RESISTANT APPLE TREE CULTIVARS

Valeria PETRE, Gheorghe PETRE

Research Station for Fruit Growing Voineşti

Corresponding author email: statiuneavoinesti@gmail.com

Abstract

The creation of new cultivars, as any productive activity, is a continuous process and is based on a technology, whose chain loops must be continuously perfected, in order to increase the efficiency. In the genetic improvement programmes, for obtaining new cultivars, the conventional methods are used – the intra- or the inter-specific hybridization, characterized by a long duration (25 - 28 years) and by high costs. The new method, with shortening of the period of obtaining the genetic disease resistant apple tree cultivars, replaces the selection field of the hybrids on own roots with a field of elites, selected in the juvenile phase from the fortification field, according to the growing and disease resistance peculiarities, grafted on low vigour rootstock (M9), planted at the definitive place at the distance of 3 x 0.5 m. The possibility to select elites is created, according to their character of resistance against diseases and to their fruits quality, during 3 - 4 years – and then the rapid transfer into competition micro-cultures. The researches performed at the Research Station for Growing Fruit Growing (RSFG) Voineşti during the 2007-2011 period, point out the fact that, by promoting of chain loops for shortening the duration of obtaining of the genetic disease resistant apple tree cultivars in the process of improvement, the time period is reduced by 30-35%, as compared to the conventional method (25 - 28 years) - and almost 5 times the area for the selection fields - and to a significant amount the costs for the creation and the putting into account of a cultivar.

Key words**:** *new methods, with period shortening, performance solutions with reduced surfaces and costs*

INTRODUCTION

In our country the genetic improvement programmes are used for obtaining new cultivars, especially conventional methods – the intra or the interspecific hybridization, characterized by long durations and high costs. Branişte N. (1987) shows that in the improvement programmes [1], for the creation of apple tree cultivars, from the hybridization till the homologation and transferring the new cultivar into production, 25-28 years are needed.

The creation of new cultivars [2], like any other productive activity, is a continuous process, based on a technology whose chain loops must steadily be perfected, in order to increase the efficiency. In the tree growing improvement, good efficiency means shorter time and fewer costs for the creation of new high quality cultivars, which shall satisfy the 3 categories of beneficiaries: the cultivators, the trade, and the consumers.

The researches performed at the RSFG Voineşti contribute to the promotion of modern ideas for the creation of new hybrid generations and of new chain loops for shortening the duration of obtaining genetic disease resistant apple tree cultivars [3].

MATERIAL AND METHODS

In the programme for the creation of genetic disease resistant apple tree cultivars, at the RSFG Voineşti, annually were realized the most diverse hybrid combinations, using matern and pattern progenitors, wich had to respond to the proposed objectives.

The researches performed during 2007- 2011 period in the experimental fields started by setting up in the spring of the year 2007 a selection field with liners of the rootstock M 9, planted at the definitive place, at distances of 2.5 x 0.5 m (8000 trees/Ha). In August 2007, on each liner were budding eyes of elites selected by the growth and by the foliage disease resistance peculiarities, issued from the

apple tree hybrids field, resulted in the fortification year 2 (hybrid series 2005) and from those in the fortification year 1 (hybrid series 2006).
The budding was repeated in the years 2008 and 2009 in the nursery fields, 2 eyes on each M 9 rootstock being budded, from each selected elite of the hybrid series 2006, 2007, respectively 2008, from the fortification fields.
In the year 1 after budding, the behaviour of the elites was followed up under the aspect of the growth evolution and of the genetic resistance against diseases,
In the fortification fields annually observations and determinations were made by appreciating the apple tree hybrids by the growth strength and by the resistance against the apple scab and mildew attack.
In the years 2-3 after grafting, in the selection fields with apple tree elites grafted on the rootstock M 9, we followed up the flowering, the fruit forming degree, the fruit quality and the resistance against diseases. From the valuable elites, which corresponded to the proposed objectives, 2 eyes of each were budded on the rootstock M 26 in the nursery, in order to set up a competition micro-culture.

RESULTS AND DISCUSSIONS

Obtaining of apple trees represents a long duration and outstanding complex activity, especially when the aim is to obtain genetic disease resistant cultivars, regardless of the used research method.
The improvement process is continuous, so that this supposes the annual creation of new selection bases, composed of hybrid dependencies which posses a complex variability, being implied as matern and patern progenitors, cultivars or genotypes that gathered valuable genetic features, so that the deadline of realizing new valuable forms shall be shortened.
The use of progenitors which posses the resistance and productivity gene, imprints into the descendent a greater transmitting rate of the valuable characters, easing somehow the improver's work.
From the hybrid combinations performed during the 2005-2006 period resulted transcendences, which formed the base of setting up the fortification fields, of which were selected the elites, which were budded on the rootstock M 9 in the especially set up selection field or in the nursery (Table 1).
From the presented data results that during the years 2005–2006 21 hybrid combinations were performed, being pollinated in total 7.986 flowers, of which resulted 2,633 hybrid apple tree seeds. The fruit forming percentage was better in the year 2006 (39.8%), but an average percentage of 32.9% was registered - harvest-able hybrid fruits. From the 2,633 fruits were obtained 12,276 hybrid apple tree seeds, with an average of 4.7 seeds/fruit, confirming that the artificial pollination assures the fecundation of all seeds.
The seeds/flowers ratio shows us that from an apple tree flower result 1.5 hybrid seeds.
From the over 10,000 apple tree hybrids obtained in the hybrid series 2005 and 2006, existing in the fortification fields, was evaluated by the growth and disease resistance characteristics a number of 151 elites, which were budded in August 2007 on the rootstock M 9, liners planted on the definitive place in the especially set up selection field.
In the year 2008, the grafts resulted as rods and were left to grow without any cutting intervention, so that a number of 15 apple tree elites differentiated fruit bearing buds, which proved to be the most precocious.
In the year 2009, over half of the budded apple tree elites bore fruits; from these 18 apple tree elites were selected by the fruits quality and by the resistance against diseases.
The reduction scheme of the obtaining duration of the genetic disease resistant apple tree cultivars is presented as follows.
After establishing the genetic resources engaged in the hybridization schemes, the seeds and the seedlings are obtained from the performed hybrid combinations. The main objective being the creation of the genetic disease resistant apple tree cultivars, the selection of the seedlings obtained in solarium may be done after a previous infection with virulent apple scab strains, being continued also on the fortification field.
These activities are common, regardless of the used improvement method (table 1). After 2

years the hybrids of the fortification field are transplanted to the definitive place in the selection orchard. For growth and fruit bearing, the hybrids need a period of at least 10-12 years, a time in which the positive mass selection for the direct observation and marking of the selected hybrids takes place, in accordance with the selection criteria (resistance against diseases, pleasant fruits aspect and taste, fruit bearing potential, etc.), their grafting in the nursery and their introduction into competition micro-cultures, in view for their promotion in the DUS test (distinctness, uniformity, stability), mandatory for the homologation.

The new method proposes a shortening of these activities, by replacing the selection field of hybrids on own roots with an field of elites, selected from the juvenile phase of the fortification field, by the growth and disease resistance peculiarities, grafted on low vigour M.9 rootstock, planted on the definitive place.

In this case there is the possibility to do in the next 2-3 years the selection for disease resistance and for the fruits characteristics and quality.

This activity takes maximum 4 years, as compared with the present scheme, which takes 10-12 years.

From the researches performed at Voineşti, the hybrid apple tree seedlings on own roots, left in the fortification field, a part of them bore fruits in the year III after planting into the hybrids nursery. Maintaining of the apple tree hybrids a longer time on own roots in the fortification field puts in account a characteristics obtained by some of the hybrid combinations – the early fruit bearing start, which leads to a duration reduction by a considerable number of years, with reduced expenses. The transplantation of the apple tree hybrids on own roots into the selection field delays the fruit bearing start - these begin to bear fruits 4-5 and even 6-7 years after planting.

In this case, the period of 17 - 18 years may be reduced by another 2 years, the hybrids selected by the growth, fruits quality and genetic disease resistance peculiarities may be grafted directly on the rootstock M 26 or MM 106 in the nursery and transferred into competition micro-cultures.

In order to enter marketing, the apple tree hybrids selected and introduced into competition micro-cultures, must go through a testing period of 2-3 years, in full fruit bearing, a testing performed by State Institute for Variety Testing and Registration (SIVTR), a time in which they verify and confirm the authenticity, the varietal purity, the agronomic and use value. The introduction into culture takes place only after they have been registered in the Official Catalogue.

By promoting the new improvement scheme for obtaining of the genetic disease resistant apple tree cultivars, the period is shortened with 8-9 years.

Also much reduced is the land area needed for obtaining and testing the hybrid material till the homologation and the promotion in culture of the new cultivar (Table 2).

From the data presented in table 2, results that at a volume of 2500 hybrid apple tree seedlings, obtained in a hybrid series, after performing the selection for disease resistance and their transplanting into the hybrids nursery for fortification, an area of 340 m^2 is needed in both methods used for the creation of new apple tree cultivars.

At the conventional method, for the transfer into the selection orchard of the 2500 hybrid seedlings an area of 10,000 m^2 is needed.

At the period shortening method, the hybrids fortified in the hybrids nursery, are not transferred into the selection orchard. By a rigorous selection by the growth and disease resistance peculiarities, results a 10% maximum of genotypes from the total hybrids number, these being grafted on M 9 liners, planted on the definitive places, at distances of 3 x 0.5 m. Results a selection orchard with about 250 hybrids selected from the hybrids nursery and 1-2 eyes budded on the M.9 liners planted at the definitive places, which will bear fruits in the year 2 and 3 after grafting, covering an area of maximum 375 m^2.

At the Voineşti Station, from 151 hybrids selected by the growth and the apple scab resistance peculiarities, grafted on the rootstock M 9, in the year 3 a number of 15 apple tree elites bore fruits. From these were

budded in the nursery 20 eyes from each elite – only from those which presented fruits and resistance against diseases, in view of setting up of a competition micro-culture, which uses for both methods about 2400 m^2.

It is found that the conventional method uses a total area of 12,740 m^2, as compared with the period shortening method for obtaining genetic disease resistant apple tree cultivars using only 3115 m^2, representing about 25%, with an area reduction of 75%.

The promotion of the method of shortening the obtaining technology of genetic disease resistant apple tree cultivars stimulates the scientific foundation of the solutions proposed for the competence increase, in accordance with the new orientations in the scientific research in the European countries with an advanced tree growing.

Table 1. Hybridization works programme and initial biological material, resulted from the hybrid series 2005 and 2006

Hybrid series	Combi-nation number	Polle-nated flowers	Obtained hybrid fruits		Hybrid seeds (nr.)	Hybrid seedlings (nr.)	Reports	
			Nr.	%			Seeds / fruit	Seeds / flowers
2005	11	5.771	1.750	30,3	9.017	7.338	5,1	1,5
2006	10	2.215	883	39,8	3.259	2.738	3,9	1,5
Total	21	7.986	2.633	32,9	12.276	10.076	4,7	1,5

Table 2. Present scheme, as compared with the scheme for shortening of the obtaining period of the genetic disease resistant apple tree cultivars

Present scheme	New scheme
- Choosing progenitors - Hybridization - Hybrid seeds - Seed stratification (1 year)	- Choosing progenitors - Hybridization - Hybrid seeds - Seed stratification (1 year)
- Sowing in flower pots or jiffy-pots in solarium - Obtaining hybrid plants (selection by disease resistance) - Hybrids transplantation into the hybrids nursery for fortification (2 years)	- Sowing in flower pots or jiffy-pots in solarium - Obtaining hybrid plants (selection by disease resistance) - Hybrids transplantation into the hybrids nursery for fortification (1 year)
- Transplantation to the definitive place in the selection orchard - Hybrids growth (6 - 8 years)	- Hybrids growth in the hybrids nursery, selection by their growth and disease resistance peculiarities) - Grafting of 1-2 eyes from the selected elites on each weak strength graft bearer (M 9) (1 year)
- Hybrids selection (Quality test) (4 years)	- Selection of hybrids grafted on graft bearer M 9 (Quality test) (2 years)
- Grafting of the elites with perspective and introducing into competition micro-cultures (2 years)	- Grafting of the elites with perspective and introducing into competition micro-cultures (2 years)
- Observing the elites behaviour in competition micro-cultures (Production test) (4 - 5 years) - Registering the valuable elites at the ISTIS	- Observing the elites behaviour in competition micro-cultures (Production test) (4 - 5 years) - Registering the valuable elites at the SIVTR
- Elites testing at the SIVTR in view of homologation (3 years)	- Elites testing at the SIVTR in view of homologation (3 years)
- Introducing into mother plantations for multiplying (3 years)	- Introducing into mother plantations for multiplying (3 years)
Total **25 – 28 years**	Total **17 – 18 years**

The nourishing surface for an apple tree hybrid, depending on the planting distance in:

- the hybrids nursery: 0,90m x 0,15m = 0,135 m^2
- the selection orchard with fortified hybrids: 4m x 1m = 4 m^2
- the selection orchard with selected hybrids from the hybrids nursery and rootstock M9: 3m x 0,5m = 1,5 m^2
- the competition micro-culture: 4m x 2m = 8 m^2

Table 3.Comparative data regarding the land area used for obtaining apple tree cultivars by the conventional method and by the period shortening method

Methods used for the apple tree cultivars creation	Used area (m^2)				
	Hybrids nursery for fortification (2500 seedlings)	Selection orchard n with fortified hybrids (2500 seedlings)	Selection orchard with hybrids selected from the hybrids nursery and grafted on M 9 (250 selections)	Competition micro-culture (15 selections x 20 trees)	Total
Conventional method	340	10.000	-	2.400	12740
Period shortening method	340	-	375	2.400	3115 (24,45%)

CONCLUSIONS

From the hybrid series 2005 and 2006, with a number of 10,076 hybrid apple tree seedlings, existing in the fortification fields. 151 elites were selected, evaluated by the growth and disease resistance characteristics – and were budded in August 2007 on the rootstock M 9, planted at the definitive places into the especially set up selection field.

By promoting chain loops for the shortening of the duration of the de obtaining genetic disease resistant apple tree cultivars in the improvement process, the time period is reduced by 30-35%, as compared with the conventional method (25-28 years) and almost by 4 times the area destined for the selection fields – and to an appreciable extent the costs for the creation and putting in account of as cultivar.

By shortening the duration of obtaining the new cultivars, the economic efficiency increases by reducing the expenses and the afferent land area, the 3 beneficiary categories: the cultivators, the trade and the consumers being satisfied in a shorter time.

New selection bases are created, composed of the hybrid transcendences with complex variability, due to implying in the hybridization process of some valuable cultivars, corresponding to the proposed objectives, which lead to the creation of new genetic disease resistant apple tree cultivars.

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