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EVALUATION OF SOME GENETIC RESOURCES USED IN THE APPLE IMPROVEMENT PROGRAM AT SCDP VOINEŞTI

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ABSTRACT

Apple improvement and the development of new varieties are of significant importance for increasing productivity and fruit quality. At SCDP Voinești, the apple improvement program began in 1950, when the first hybrid combinations were made, and has continued to this day. Over time, varieties or genotypes with a high level of genetic resources have been used as parents, especially for obtaining apple varieties with genetic resistance to diseases. From the numerous hybridisations performed, valuable elites were identified. This paper presents the characteristics of three elites with resistance to Venturia spp. and partial to powdery mildew, high productivity and fruit quality: H 4/17-04; H2/3-04; H 19/6-04.

INTRODUCTION

The improvement of apple and the development of new varieties is of significant importance for increasing productivity, fruit quality, resistance to diseases and pests, adaptability to local conditions, diversification of supply and benefits to growers (Laurens 1998, Sansavini et al. 2004). Through genetic improvement, apple varieties can be developed to be more resistant to diseases and pests, which reduces reliance on pesticides and can have a positive impact on the environment. This objective has been a major one in apple improvement programs (Crosby et al. 1990, Gessler & Pertot 2012, Patocchi et al. 2020). As a result of the improvement programs, apple varieties adapted to different geographical areas and specific climatic conditions were obtained, which allowed the successful cultivation of the apple in various areas and the diversification of the apple supply (Sedov et al. 2020, Ulianovskaya & Belenko 2021), giving consumers more options when it comes to choosing fruit. Apple improvement has brought economic benefits to apple producers through superior utilization of the fruit, which can increase farmers' incomes and contribute to the development of the agricultural economy (Sestras & Sestras 2023). At SCDP Voinești, the apple improvement program began in 1950, with the establishment of the station, when the first hybrid combinations were carried out (Petre et al. 2020, Cociu et al. 1999). The program has continued up to the present time, and over time varieties or genotypes with a high level of genetic resources have been used, especially to obtain apple varieties with genetic

resistance to diseases. In intra- and interspecific hybridisation work and repeated crosses, a number of apple cultivars or genotypes with genetic resistance to diseases with valuable fruit productivity and quality characteristics were used as maternal and paternal parents (Militaru et al. 2009, Petre et al. 2017, 2019, 2020, Comănescu et al. 2011, Petre & Petre 2014). This paper aims to present some elites of success obtained in the apple improvement program at SCDP Voinești.

MATERIAL AND METHODS

The observations were made at Voineşti Research and development station for fruit growing (45°4′12″N 25°14′58″E) which has a complex genetic base, composed of selection fields, hybrid nursery and contest microcultures. They are the main source for the selection of valuable elites used in the apple improvement program to obtain disease-resistant varieties. The improvement process being of particular complexity, especially when obtaining apple varieties with disease resistance, the results obtained from the hybrid combinations carried out in the period 2016-2020, including those from 2023, were evaluated. The hybrid combinations are presented, accompanied by the number of pollinated flowers, the number of seeds obtained and the resulting hybrids, existing in the selection fields. Within the improvement program, potential parents and valuable apple elites were identified from the competition microcultures and the proposed selection fields for new hybrid combinations, or obtaining new varieties (Gavrilă & Petre 2022).

RESULTS AND DISCUSSIONS

The apple improvement process is continuous, and its success is conditioned by the clarity of the proposed objectives, the existence and knowledge of genetic resources and the use of valuable parents. The use of parents that possess the resistance and productivity gene, imprints in the offspring a higher rate of transmission of valuable characters, characteristics that are highlighted based on subsequent research (Ulyanovskaya & Belenko 2020, Peil et al. 2021, Luo et al. 2020).

a) Evaluation of apple hybrid combinations, carried out during the period 2016 – 2023

The results obtained regarding the evaluation of disease resistance, in the seedlings from the apple hybridisation program, in the period 2016-2020 are presented in table 1. In the period 2016-2020, apple hybrid combinations were carried out, using valuable parents in terms of genetic resistance to Venturia Spp., possessors of the Vf gene. From the data presented in table 1, it follows that 1,765 flowers from 14 hybrid combinations were pollinated, from which a number of 1,131 hybrid seeds were obtained. After a first selection for resistance to Venturia Spp., 915 hybrids were transplanted into the fortification field, representing a percentage of 51.8% compared to the pollinated flowers and 80.9% compared to the number of hybrid seeds sown. In the fortification field, the apple hybrids vegetated properly, annually being analysed according to the criterion of resistance to the attack of the main diseases and according to visible morphological characters. Of the 915 hybrids transplanted in the fortification field, 428 were selected in the selection fields, representing a percentage of 45.3% compared to the number of hybrids obtained initially. Hybrid apple combinations 'Goldrush' x H 1/59, 'Sirius' x H 1/59 from 2017 hybrid series, 'Topaz' x H 1/16, 'Valery' x 'Cezar' from 2018 hybrid series, obtained the highest percentage of Venturia Spp resistant hybrids from the resulting seedlings, in percentage of over 50%.

Table 1

Evaluation of disease resistance in seedlings from the apple hybridisation program in the period 2016-2020, at SCDP Voinești

Crt no.	The hybrid combination	No. flower pollinated	No. hybrid seeds	Resulted seedlings	Venturia Spp. resistant hybrids in the selection field	
					Nr.	%
	2016 hybrid series					
1	Inedit x Opal	186	100	77	32	41,6
2	Luna x Iris	127	83	68	29	42,6
3	Ariwa x H 8/86	110	89	75	36	48,0
	Total	423	272	220	97	44,1
	2017 hybrid series					
1	Golsrush x H 1/59	72	26	15	8	53,3
2	Goldrush x Inedit	92	29	17	7	41,1
3	Sirius x H 1/59	80	17	10	6	60,0
4	Sirius x Inedit	160	59	36	16	44,4
	Total	404	131	78	37	47,4
	2018 hybrid series					
1	Topaz x H 1/16	306	195	164	82	50,0
2	Valery x Cezar	164	130	94	50	53,2
3	Goldrush x H 1/8	102	69	48	21	43,8
	Total	572	394	306	153	50,0
	2020 hybrid series					
1	Goldrush x H 4/17	230	151	119	56	47,1
2	Florina x H 1/12	165	122	86	41	47,7
3	Goldrush x H 14/1	215	133	116	44	37,9
4	Total	610	406	311	141	45,3
	TOTAL GENERAL	1.765	1.131	915	428	46,8
	% reported to no of flowers		64,1	51,8	428	24,2
	%reported to no of hybrid seeds			80,9	428	37,8

In 2023, a number of 5 hybrid combinations were carried out, according to the following scheme: (1) 'Gala' x 'Florina' - by pollinating 610 flowers, from the combinations, 100 hybrid fruits resulted; (2) 'Pinova' x 'Florina' - by pollinating 460 flowers, from the combinations, 60 hybrid fruits resulted; (3) 'Jonaprince' x 'Remar' – by pollinating 516 flowers, 20 hybrid fruits resulted from the combinations; (4) 'Red Velox' x 'Idared' - by pollinating 580 flowers, from combinations, 98 hybrid fruits resulted; (5) 'Red Velox' x 'Remar' - by pollinating 650 flowers, from the combinations, 30 hybrid fruits resulted. The first 2 hybrid combinations, 'Gala' x 'Florina' and 'Pinova' x 'Florina', were performed by isolating the flowers of the maternal partner and pollinating them with mature pollen from the paternal partner. To the other combinations 'Jonaprince' x 'Remar', 'Red Velox' x 'Idared' and 'Red Velox' x 'Remar', the flowers of the maternal partner were castrated by total removal of the stamens and pollination with mature pollen from the paternal partner. Until now, the results obtained consist in the obtaining of hybrid fruits which, in the hybrid combinations made by isolating the paternal partner, from 1070 pollinated flowers, 160 hybrid fruits were obtained, respectively 14.95% degree of binding. In the combinations where the flowers were castrated, from the pollination of 1746 castrated flowers, a number of 148 hybrid fruits resulted, the binding percentage

being 8.48%. The reduced degree of fruit binding, between 8.48 and 14.95%, is due to the less favourable climatic conditions, with rains and low daily maximum temperatures of 18-19ºC. From the harvested fruits, the seeds are removed, conditioned and prepared for post-ripening and sowing in jiffy tablets. The apple seedlings from the 2018 hybrid series, existing in the fortification field, were analysed from the point of view of vegetative growth, achieved in the first year after planting (table 2). The vegetative growth expressed by the height of the seedlings (cm) in the hybrid nursery, after one year of vegetation, is presented as follows: out of 306 analysed hybrids, obtained from 3 hybrid combinations, 94 had a height between 20-50cm (30.7%); 123 between 50-80 cm (40.2%) and 89 with a height over 80 cm (29.1%). The lowest growth vigour was recorded in the hybrids resulting from the hybrid combination 'Valery' x 'Cezar', respectively 40,4% with a height between 20-50 cm.

Table 2

The vegetative growth of seedlings in the hybrid nursery, in the first year of vegetation (series 2018)

Crt. No.	The hybrid combination	Analysed seedlings	The height of the seedlings (cm)					
			20-50		50-80		> 80	
			Nr.	%	Nr.	%	Nr.	%
1	Topaz x H 1/16	164	49	29,9	68	41,4	47	28,7
2	Valery x Cezar	94	38	40,4	29	30,8	27	28,8
3	Goldrush x H 1/8	48	7	14,6	26	54,1	15	31,3
	TOTAL	306	94	30,7	123	40,2	89	29,1

With the transplantation of apple hybrids obtained in Jiffy tablets, in the field of fortification, it is found that after one year, the vegetative growth reaches values of 20-80 cm, in which year, after a prior positive mass selection, considering the criterion of disease resistance, vigour and other characteristics, a branch can be harvested and graft 2-3 eyes onto the M9 rootstock. Grafted nursery trees are planted in competition microcultures and further selected after at least 3-4 years regarding disease resistance, pleasant appearance and taste of the fruits, fruiting potential, etc.

If the selection is not carried out according to the vegetative characteristics, the hybrids on their own roots are left in the fortification field, becoming a selection field, until the first fruits are obtained, the selection being carried out according to the resistance to diseases and the quality of the fruits. There are situations when apple hybrids obtained from certain combinations, still being on their own roots, bear fruit as early as the 3rd year after planting (Petre & Petre 2013).

b) The apple elites registered at ISTIS for tests with the purpose of homologation

From the apple contest microcultures, three elites were identified with resistance to Venturia Spp. and partial to powdery mildew, productivity and fruit quality: H 4/17-04; H2/3-04; H 19/6-04 which are described below.

Elite H 4/17-04 was obtained by sexual hybridisation from the combination 'Goldenspur' x 'Florina'. The tree is of low-medium vigour, precocious, bears fruit on short formations. Flowering is mid to late. The fruit has an average of over 165g, conical, yellow on the entire surface. The flesh is yellowish, crunchy, with a very good taste. Harvest maturity begins with the first decade of October, and the consumption period extends until March 1st. Elite is resistant to attack by *Venturia inaequalis* and *Podosphaera leucotricha*. It stands out for its precocity, resistance to

the attack of the main diseases, fruiting on short formations, excellent fruit quality and good storage capacity over the winter.

Elite H 4/17 – 04

Elite H 2/3-04

Elite H 19/6 – 04

Figure 1. Valuable elites obtained in the improvement program at SCDP Voinești

Elite H 2/3-04 was obtained by sexual hybridisation from the combination 'Florina' x 'Idared'. The tree is of low - medium vigour, very precocious, bears fruit on short and long branches. The flowering is medium; the flower bud is light pink. The fruit is on average over 165g, yellow-green in colour, covered on 3/4 of the surface with red. The flesh is white - yellowish, crunchy with good taste. The harvesting season begins in the last decade of September, and the consumption season lasts until January. Elite is resistant to the attack of *Venturia inaequalis* and *Podosphaera leucotricha*. It stands out for its precocity, resistance to the attack of the main diseases, fruit quality, with storage until January.

Elite H 19/6 – 04 was obtained by sexual hybridisation from the combination 'Florina' x 'Idared'. The tree is of low-medium vigour, spread out, bears fruit on short and long branches. Flowering is late, the flower bud is dark pink, and the petals are overlapping. The fruit is on average over 160 g, dark red in colour, covered on 3/4 of the surface. The shape of the fruit is obloid. Yellowish-white flesh, crunchy with good taste. Late harvest maturity, with consumption maturity by March. Elite is resistant to attack by *Venturia inaequalis* and *Podosphaera leucotricha*. It stands out for its resistance to the main diseases, quality of the fruits, with storage over the winter.

CONCLUSIONS

In conclusion, apple improvement is of crucial importance for fruit growing and for society as a whole, contributing to ensuring food security, improving the quality of food products and protecting the environment by reducing the use of pesticides.

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