ment apparently lead to the poor winter hardiness ratings in that study, and mid-winter injury was not the primary cause of damage.

Unlike some previous reports (2, 6) killing temperature during the winter of 1993-1994 occurred when vines were in the deepest state of dormancy and fully acclimated, so these data represent a good measure of maximum winter hardiness for these cultivars. This undoubtedly accounts for the high rate of bud survival compared to previous reports. These data should be of value in planning future studies and making recommendations to growers.

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Apple Breeding in Romania*

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The apple is second only to plum in important fruit crops in Romania. Apples now account for approximately 30 percent of the acreage and output of Romania's fruit production. The most widely grown cultivar is 'Jonathan,' followed by 'Golden Delicious,' 'Red Delicious,' 'Parmain d'Or,' 'Idared,' and a few local cultivars such as 'Cretesc' and 'Patul.' (5)

The production of fruit crops has reached more than 600,000 metric tons annually; thus great importance has been placed on varietal improvement, either by introduction of foreign cultivars or by developing our own apple breeding program.

Apple breeding in Romania began in 1948, when the first formal program was initiated by N. Constantinescu at

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ICAR, Bucharest. The first experimental stations at Bistrita, Voinesti, and Cluj were established in 1950-1953.

The main breeding objectives were to produce good quality fruit (size, taste, color) and to increase the cultivars' resistance to scab and powdery mildew. With respect to that, numerous intra- and interspecific hybrid combinations with valuable genitors (parents) have been carried out. At Voinesti, the first interspecific hybridizations were made between 1952 and 1953, crossing 'Parmain d'Or' and 'Jonathan' as pistillate parents with the wild species *Malus zumi, M. kaido, M. floribunda, M. coronaria,* and *M. prunifolia* carrying one or more genes resistant to scab. (4)

The first generation (F1), with only a few plants, set fruit between 1957 and 1960. Selection of hybrids under natural disease infection conditions, without chemical treatments, emphasized 8 lines with very high scab resistance. Among those, five F1 selections (52-18-3 and 53-18-5 of 'Jonathan' x *M. zumi,* 53-38-5 of 'Parmain d'Or' x *M. floribunda,* 53-39-1 and 53-39-3 of 'Parmain d'Or' x *M. kaido*) were used in further crosses for disease resistance after 1960. (6)

After crosses with 'Jonathan,' 'Starking Delicious,' and 'Winter Banana,' F2 selections from these parents with big fruit (up to 110g) and a high scab resistance were made (60-17-84, 'Jonathan' x *M. zumi*) x 'Winter Banana'; (60-6-51 of 'Parmain d'Or' x *M. kaido*) 'Jonathan'; (60-15-222 of 'Jonathan' x *M. zumi*) x 'Winter Banana,' etc. (2, 6)

In 1967, other valuable parents, such as 'Frumos de Voinesti,' 'Delicios de Voinesti,' 'Wagner,' and 'Mutsu,' were used in 130 combinations; 16,000 hybrid seedlings were produced.

At that time, D. Blaje at Bistrita and R. Polacsay and St. Oprea at Cluj made interspecific crosses ('Wagner' x *M. spectabilis;* 'Gustav durabil' x *M. purpurea*), also using in their hybridization old local varieties which would enhance quality and disease resistance. In addition, during this period, the breeders made successful use of such female and male parents as the local varieties 'Calugaresc,' 'Cretesc mare de Valcea,' 'Masanschi,' and 'Marul de Sugag.' As a result of that breeding work, several cultivars—'Frumos de Voinesti,' 'Delicios de Voinesti,' 'Rosu de Cluj,' and 'Aromat de vara'—were named and commercially grown (1966-1967). (see Table 1)

The visit of Dr. L. F. Hough, Rutgers University (U.S.A.), to Romania in 1970 was an important event. It provided a strengthening of cooperative relationships and the beginning of a long-term breeding program (1970-1980). New gene sources introduced by that program accounted for 85,000 hybrid seeds in Romania and 20,000 in the U.S.A. All have been assessed at Pitesti and Voinesti.

Out of this material, 3 new cultivars were released: 'Romus 1,' 'Romus 2,' and 'Romus 3.' (see Table 1) They each ripen in early fall or late summer, like 'Jonathan,' and have high resistance to scab and powdery mildew. (1)

Introduction of gene Vf for scab resistance from 'Prima' cultivar, in the present breeding work, has resulted in selection of 'Pionier,' 'Voinea,' and 'Generos' cvs., released in 1985 and 1986. (3) (see Table 1)

Another breeding objective has been the incorporation of genes with disease resistance originating from various initial sources. During the 1980-1990 period, we made crosses with F2, F3, and F4 selections carrying resistance genes acquired from back-crossing to *M. floribunda* 821, *M. kaido,* and *M. zumi.* For the desired quality characteristics, parents such as 'Florina,' 'Liberty,' 'Generos,' and 'Voinea' were used. The major breeding objective has been to create cultivars that are similar to

Table 1. Cultivars, and their origins, released from Romanian breeding programs.

No.	Cultivar	Year	Parentage	Breeders	Location
1.	Aromat de vara	1966	Parmain d'Or x Jonathan	St. Oprea	Cluj
2.	Rosu de Cluj	1966	Jonathan x Senator	R. Palocsay	Cluj
3.	Frumos de Voinesti	1967	Jonathan x Belle de Boscoop	Gh. Moruju	Voinesti
4.	Delicios de Voinesti	1973	Golden x Cretesc	Gh. Moruju	Voinesti
5.	Ancuta	1979	Jonathan x Sugag	St. Oprea	Cluj
6.	Felcac	1979	Jonathan	St. Oprea	Cluj
7.	Radaseni	1979	Jonathan	C. Radulescu	Falticeni
8.	Falticeni	1979	Jonathan x Wagner	C. Radulescu	Falticeni
9.	Ardelean	1980	Jonathan x Peasgood	St. Oprea	Cluj
10.	Baia Mare 26	1980	Jonathan	A. Lazar & I. Popa	Baia Mare
11.	Gloria	1982	Jonathan x Cardinal x (Gustv durabil x Van Mons)	D. Blaja & T. Tetileanu	Tirgu Jiu
12.	Delia	1982	Jonathan x Wagner	Gh. Moruju, A. Lazar, & I. Popa	Baia Mare
13.	Pionier	1983	(Jonathan x Verzisoare) x Prima	Gh. Moruju & L. Serboiu	Voinesti
14.	Generos	1983	Frumos de V. x (Parmain d'Or x M. kaido) x Jonathan	Gh. Moruju & L. Serboiu	Voinesti
15.	Romus 1	1984	Complex F4 Hybrid	N. Braniste, L. F. Hough, & V. Cociu	Pitesti
16.	Romus 2		Same date, parentage, breeders, & location		
17.	Romus 3		Same date, parentage, breeders, & location		
18.	Voinea	1985	Frumos de V. x Prima	Gh. Moruju & L. Serboiu	Voinesti
19.	Auriu de Bistrita	1989	Golden D. x Parmain d'Or	I. Ivan & N. Minoiu	Bistrita
20.	Poiana	1991	Frumos de V. x (Parmain d'Or x M. kaido) x Jonathan	Gh. Moruju, L. Serboiu, & I. Popa	Lipova
21.	T 120	1991	Complex F4 hybrid	L. F. Hough, V. Cociu, & C. Vulpe	Lipova
22.	T 195	1991	Complex F4 hybrid	same breeders	Lipova
23.	Remus	1994	Complex F4 hybrid	N. Braniste, M. Raduc, V. Amzar, & M. Radulescu	Pitesti

'Jonathan' or 'Golden Delicious,' have a high degree of disease and pest resistance, and have varied maturities.

Presently, the main objective of our program is to produce apples of top quality and polygenic fire blight resistance. Yearly, 30,000 to 50,000 flowers are hybridized in 4 separate locations in Romania. There are about 40,000 apple hybrids (1-7 years old) and more than 350 promising selections under evaluation. At Voinesti and Pitesti we have 65 resistant selections based on sources with polygenic scab resistance, such as 'Liberty,' 'Nova,' 'Easygro,' 'Florina,' and 'Priam.' Advances made in apple breeding during the past 45 years in Romania have resulted in the release of 23 cultivars; all are commercially grown, comprising about 25% of fruit production.

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Apple Fruit Size on Lateral Bloom

'Golden Delicious' fruit produced on 1- compared to 2-year-old wood were smaller due to significantly lower cell numbers and smaller cell diameters. Dry matter content of fruits from terminal or lateral inflorescences were similar but higher for apples obtained from younger wood. The concentrations of main sugars (sucrose, fructose, glucose, and sorbitol) were greater in peripheral fruit compared to central (king) fruit, but there were no differences between age of the wood.

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I certify that the statements made by me above are correct and complete. R. M. Crassweller, Business Manager. December 30, 1996.