

The History of the Vineland (V.) Apple Rootstocks

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Abstract

The Vineland (V.) rootstocks originated at the Horticultural Research Institute of Ontario, Vineland Station, as open-pollinated seedlings of 'Kerr' applecrab. Dr. Aleck Hutchinson made seven selections at Vineland. Five selections have received some testing as rootstocks, while two remain untested. Tree-size control among the five tested selections varies from smaller than M.9 EMLA to approximately M.7 EMLA. Precocity, productive efficiency, fireblight survival data, and their cold-hardy and fireblight-resistant ancestry suggest that these rootstock selections merit more extensive testing. Three selections (V.1, V.2, V.3) will be included in the 1994 NC-140 apple rootstock evaluation planting.

In 1958, Dr. Aleck Hutchinson initiated a project at the Horticultural Experiment Station at Vineland Station, now the Horticultural Research Institute of Ontario (HRIO), to breed and select superior cold-hardy, dwarfing apple rootstocks for Ontario. The primary objectives were to develop fully-dwarfing rootstocks adapted to the Ontario climate of colder winters and warmer summers than the maritime climates of Europe where the Malling rootstocks originated. In addition to cold hardiness and size control, other characteristics sought included ease of propagation, precocity, and resistance to pests and diseases.

Because the two principal objectives of the breeding project were cold hardiness and size control, Dr. Hutchinson's strategy was to use genetic sources exhibiting outstanding characteristics of hardiness, dwarfing, and/or precocity. M.9 was chosen as parent because of its dwarfing capability.

M.9 forms a small tree even when ungrafted. However, M.9 is not reliably hardy in the colder apple-growing districts of Ontario (5). In Ontario, trees on M.9 have been lost due to winter injury (9, 10). The root structure of M.9 includes very thick bark as well as brittle wood high in parenchyma cells and low in fibers. These root characteristics are genetically determined and have been associated with dwarfing (3).

Hardy *Malus* types also used as parents include 'Dolgo' crabapple (*Malus baccata*), 'Kerr' applecrab, 'Strathmore' red-leaved crabapple (*M. niedwetzkiiana*), and *M. x robusta* 5. Dr. Hutchinson obtained open-pollinated seed collections from all of these cultivars. Some crosses of M.9 with these hardy *Malus* cultivars were also made. Seed collections were carried out between 1957 and 1963. One open-pollinated seed collection from 'Kerr' applecrab resulted in seven seedling selections that became the Vineland (V.) rootstocks (Fig. 1).

'Kerr' applecrab, a seedling of 'Dolgo' x 'Haralson' (4, 11, 12), is extremely hardy, medium in vigor and is very productive in the prairie environment. 'Kerr' scions rooted readily when grafted on inverted seedling roots, forming massive, multi-branched root systems (14). 'Dolgo' crabapple and 'Haralson' apple, the parent cultivars of 'Kerr,' are noted for their hardiness and productivity in very cold climates (7, 12, 13). Own-rooted 'Haralson' trees displayed a high tolerance to alkaline soils (16).

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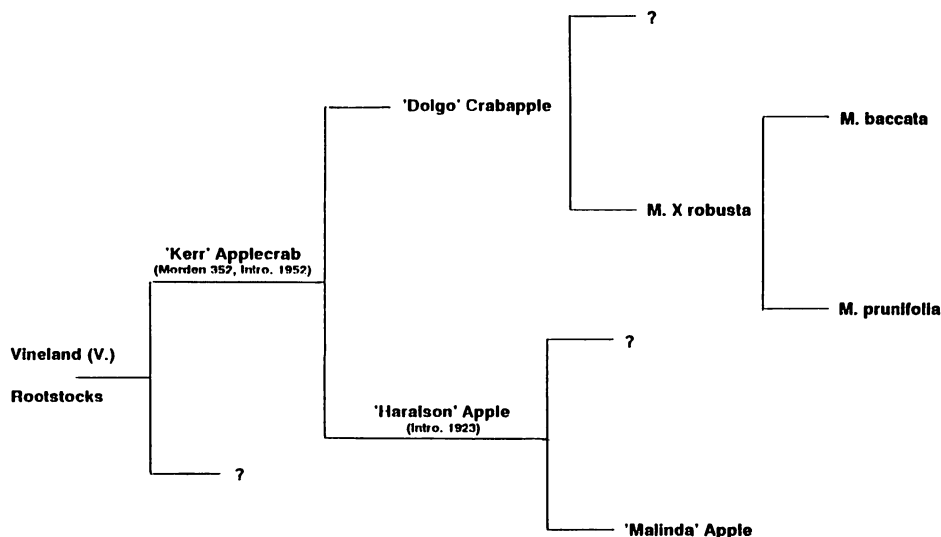


Figure 1. The pedigree of the Vineland (V.) rootstocks.

Dr. Hutchinson made the first seed collections in the fall of 1957 while a graduate student at MacDonald College of McGill University in Montreal, Quebec. Open-pollinated seed was collected from M.9 and 'Kerr' applecrab trees growing in relative isolation in a block at the college. Dr. Hutchinson completed his Ph.D degree at McGill in 1958 and transferred to Vineland in August of that year. Seedlings originating from the 1957 collections were planted at Vineland in 1959. In 1959, open-pollinated 'Kerr' and M.9 seeds from the same block were collected through the assistance of Dr. C. D. Taper of the Dept. of Horticulture at MacDonald College and the seed sent to Vineland. These two collections were stored until 1960, when they were stratified along with seven additional 1960 seed collections from young, fruiting 'Dolgo,' 'Kerr,' 'Strathmore,' and M.9 trees planted at Vineland and crosses of M.9 with each of the other three cultivars. Each seed collection was identified with a "V60" series number relating to the year 1960. The 680 seeds collected in 1959 from open-pollinated fruit of 'Kerr' apple-

crab at McGill College were assigned the accession code V605.

Seeds from the 1959 and 1960 collections were planted in flats of soil mix on October 20, 1960 and placed in cold storage to break embryo dormancy. The flats were moved to a cold frame on January 12, 1961 and held at 10C until January 30, when they were moved to the greenhouse and held at about 21C day temperature. Seedlings were transplanted from the germination flats in March, placed in cold frames in late spring, and lined out in the field at a spacing of 1.2 x 1.2 m on June 24, 1961.

Seedlings originating from all collections were evaluated in the field at Vineland over several years. The criteria used in selecting seedlings for further evaluation are described below.

1. Growth habit. Leaf and shoot morphology was the first selection criterion applied to seedlings in the nursery row. Seedlings displaying large, thick leaves and thick stems with short internodes were considered as potentially dwarfing. At ages 5 or 6 years, previously-selected

seedlings that failed to maintain a dwarf stature were discarded. Few seedlings having M.9 as a parent maintained its size-controlling characteristics.

- 2. Bark thickness. Relatively thick root and shoot bark is typically found in dwarfing rootstocks and is a prominent characteristic of M.9 (3). These characters were evaluated visually when selections were pruned or rooted shoots removed from stoolbeds. Seedlings showing this character were considered to have significant potential for dwarfing.
- 3. Hardiness. Selections were evaluated for winter hardiness in February and March, 1970 by exposing the tops of intact, dormant plants in the field to -40C for 24 hours with liquid N₂ in a small, portable cold chamber. Selections responding with significant cold injury were discarded. On November 1, 1978, selections were visually rated from 1 to 5 for abscission of foliage and from 1 to 5 for loss of chlorophyll in foliage as indices of early hardening and maturity of wood (1 = no leaf loss, no chlorophyll loss; 5 = complete leaf loss, leaves with little or no green color).
- 4. Ease of propagation. Presence of aerial rooting and burrknots in seedling material suggested the potential for relative ease of propagation. Stooling tests were carried out on previously selected clones after their third year of growth to determine ease of rooting. Difficult-to-root selections were discarded. Because rooting appears to be the expression of multigenic recessive traits (8), all seedling populations contained only small numbers of easily-rooted clones.
- 5. Disease and insect resistance. Powdery-mildew (*Podosphaera leucomotricha*) infection varied with season and source of the seedling population. Seedlings susceptible to powdery mildew were eliminated within

Table 1. Visual ratings of leaf drop and loss of foliar chlorophyll as indices of early hardening of apple rootstock material.

Rootstock	Foliage Rating (1-5) ^z	
	Abscission ^y	Color ^x
V.4	4	4
P.18	4	4
B.54-118	3	5
V.1	3	4
V.2	3	4
V.3	3	4
V.5	3	4
V.7	3	4
O.3	3	4
B.57-146	2	4
B.57-490	2	4
CG.24	3	3
M.26	2	4
P.2	3	3
P.22	2	3
B.9	1	3
CG.10	1	3
M.7	1	3
P.13	1	3
P.16	1	3
M.9A	1	2
MM.106	1	2
MM.111	1	2
P.1	1	2

^zRatings by Dr. A. Hutchinson, Nov. 1, 1978.
^yRating scale: 1= no leaf drop; 2 1= up to 10% leaf drop; 3 1= 10-50% leaf drop; 4 1= 50-95% leaf drop; 5 1= all leaves abscised.
^xRating scale: 1 1= all leaves green; 2 1= up to 10% of leaves with color change; 3 1= 10-50% of leaves with color change; 4 1= 50-95% of leaves with color change; 5 1= all leaves with color change.

the first two years in the field. No natural infections of fireblight (*Erwinia amylovora*) were observed in any of the seedling populations or final selections. 'Dolgo,' 'Kerr' and 'Haralson' are all rated as resistant to fireblight (15, 17). Selections infested with woolly apple aphid (*Eriosoma lanigera*) were discarded.



Figure 2. Leaf and shoot morphology of six V. selections.

A—V.1;

B—V.2

C—V.3;

D—V.4

E—V.5;

F—V.7

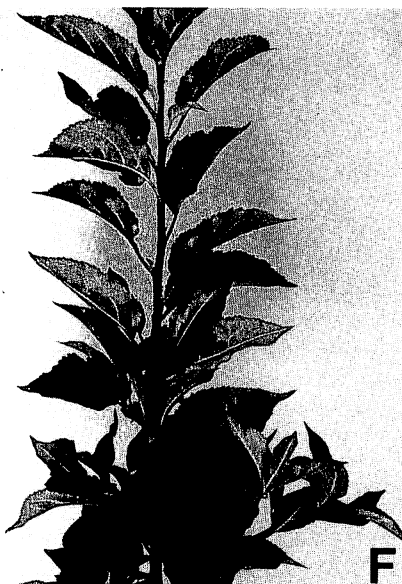
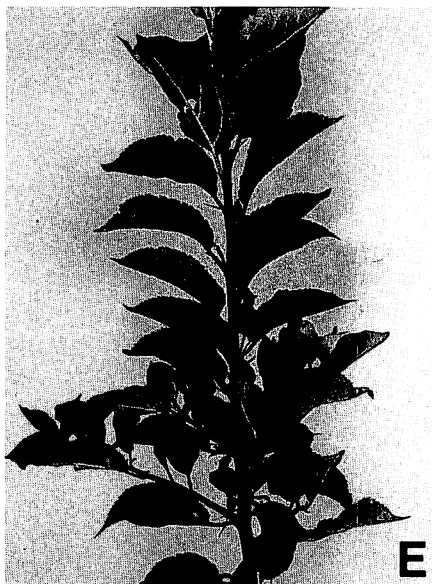


Table 2. Performance of 'Smoother Golden Delicious' (GD), 'Granny Smith' (GS) and 'Redchief Delicious' (DEL) apple trees on various size-controlling rootstocks at Wenatchee, WA. The trees were planted in 1986.^z

Rootstock	Trunk cross-sectional area 1991 ^y (% of M.9 EMLA)	Cumulative yield/tree 1991 (% of M.9 EMLA)		Cumulative yield efficiency ^x (% of M.9 EMLA)	
		GD, GS ^w	DEL	GD, GS ^w	DEL
M.27	41	31	25	80	65
V.3	63	69	66	127	88
P.22	64	69	52	113	92
MAC.9	67	82	65	120	91
M.9	72	75	52	102	78
Mark	73	76	44	110	66
CG.10	88	77	72	86	92
M.9 EMLA	100	100	100	100	100
V.1	109	97	107	105	89
B.9	115	116	145	108	113
MAC.39	130	83	133	79	78
M.26 EMLA	149	105	159	81	89
V.7	156	114	166	70	120
V.2	181	117	156	66	90
OAR 1	224	51	101	25	43
P.1	240	98	174	44	67
V.4	248	124	198	51	77

^zModified from Barritt (1992). All trees supported and trained to the slender spindle system.

^yMeans of the 3 cultivars.

^xCumulative yield through 1991/trunk cross-sectional area 1991.

^wMeans of GD and GS combined.

Table 3. Performance of 'Macspur McIntosh' (MMcI) and 'Lawspur Rome' (LR) apple trees on various size-controlling rootstocks in southern Ohio. The trees were planted in 1986.^z

Rootstock	Trunk cross-sectional area 1991 ^y (% of M.9 EMLA)	Cumulative yield/tree 1991 ^y (% of M.9 EMLA)	Cumulative yield efficiency 1991 ^{y, *} (% of M.9 EMLA)	Tree Loss 1986-1990 (%) ^w	
				MMcI	LR
MAC.9	33	45	79	50	30
Mark	33	52	104	30	20
P.22	38	57	85	20	20
M.27 EMLA	42	18	53	20	0
B.9	65	55	83	0	-
V.3	73	61	74	20	0
M.9	74	88	108	60	0
CG.10	76	109	126	30	0
V.1	77	78	107	10	0
MAC.39	86	100	144	10	70
M.9 EMLA	100	100	100	40	10
M.26 EMLA	106	120	106	60	60
V.2	132	68	70	0	10
M.7 EMLA	136	72	59	10	0
V.7	149	96	72	0	0
V.4	162	88	60	10	0
P.1	183	85	64	10	0
OAR 1	221	66	34	0	0

^zModified from Ferree (1992). All trees supported and trained to the central-leader system.^yMean values of the two cultivars.^{*}Cumulative yield through 1991/trunk cross-sectional area 1991.^wPercentage of 10 trees for each station at planting; losses due primarily to fireblight.

Among hundreds of seedlings selected from the numerous seed collections over the years, seven open-pollinated 'Kerr' seedlings originating from the V605 collection displayed desirable selection criteria and were initially designated as V605-1 to V605-7 (now V.1 to V.7). Because of growth habit, tree size, bark characteristics, and the presence of only 'Kerr' and M.9 trees in the block from which the seed originated, the V. seedling selections are all thought to have M.9 as a pollen parent (Fig. 2). In 1978, the V. selections achieved higher ratings for foliar abscission and color change than almost all other rootstocks evaluated, including several widely used in North America (Table 1). When the rootstock breeding project was terminated in

1971, the V. selections were still under evaluation but had not yet been tested as rootstocks.

In 1974, a few trees each of 'McIntosh,' 'Delicious,' 'Spartan,' and 'Idared' budded on V.1, V.2, V.3, V.4, B.9, and O.3 were planted in a preliminary trial at Vineland. They were removed in 1980. Observations by Dr. Hutchinson indicated that V.1 and V.3 produced the smallest trees, near M.9 EMLA in size, V.2 was approximately M.26 EMLA size, and V.4 was the most vigorous, approximately equivalent to M.7 EMLA in size.

The seven V. clones were maintained at HRIO in Vineland until 1979. In January, 1979, 125 plants comprising the selections V.1, V.2, V.3, V.4, and V.7 were sent to Oregon Rootstock

(now TRECO, Inc.) in Woodburn, Oregon for possible inclusion in NC-140 trials. All rootstock material of the V. series at Vineland was removed in 1979 following Dr. Hutchinson's retirement in March of that year. Dr. Hutchinson has privately maintained plant material of all seven V. selections since that time. All V. selections will be established at the Horticultural Experiment Station in Simcoe.

Recent reports from Washington and Ohio provide the first extensive evaluations of five of the V. selections as rootstocks (1, 2, 6). V.1 and V.3 look especially promising in comparison to M.9 EMLA, displaying excellent size control and yield efficiency (Tables 2, 3). V.2 and V.7 produced trees in the M.26 to M.7 size and productivity range, while V.4 produced larger trees. In Ohio, the V. rootstocks showed outstanding survival against fireblight compared to other size-controlling rootstocks in that trial (Table 3). No data are available on the performance of V.5 or V.6 as rootstocks. The selections V.1, V.2, and V.3 will be included in an NC-140 apple rootstock trial to be planted in 1994 at many research stations throughout North America. V.4 and V.7 merit further evaluation where a larger tree in the M.7 size range is desired, or where low-vigor cultivars such as spur 'Delicious' or 'Braeburn' are used.

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