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Growth and Production of 'Starkspur Supreme Delicious' on 9 Rootstocks in the NC-140 Cooperative Planting[1]

NC-140

Abstract

In 1980-81 'Starkspur Supreme Delicious' on 9 rootstocks were planted at 27 sites in the United States and Canada according to guidelines established for cooperative testing by NC-140. The greatest tree loss occurred with Ottawa 3 (30%) followed by M.27 EMLA (22.8%), M.9 EMLA (20.0%) and MAC 24 (15.6%) with less than 10% death of trees on other rootstocks. Trees on M.27 EMLA were the smallest and trees on MAC 24 the largest. Trees on M.9 EMLA, M.9 and MAC 9 were not significantly different in trunk cross-sectional area. Trees on MAC 9 had high early yields and yield efficiency and trees on MAC 24 and OAR 1 were relatively slow to begin production in most sites. In addition to growth and yield measurements, other pomological characteristics influenced by the rootstocks were evaluated and reported.

The trend to higher density orchards of smaller-sized trees continues to have an increasing impact upon apple production and economic return in North America. These high density plantings provide economic efficiencies based upon size-controlling rootstocks, new tree training systems, increased productivity, improved fruit quality, and other management techniques suited to small farms and commercial orchards. In converting from large- to small-sized trees, the industry faces various problems in the selection of a rootstock. Without adequate sustained research, newer apple rootstocks cannot be recommended without reservation as to soil and climatic adaptability, anchorage, tree size control, precocity, productivity, pest resistance, or propagation.

Evaluations of potential apple rootstock and interstem systems have been made independently by researchers in many states in the past. The lack of common planting materials, spacings and handling procedures have made comparison of the results from these studies difficult. Growers have planted many trees too close on their soils because of this lack of information.

In order to overcome the above problems, the NC-140 rootstock-scion committee initiated a series of test plantings to evaluate new and untested rootstock and interstem candidates by means of cooperative plantings. Through uniform cooperative testing in a number of fruit growing areas, each investigator could benefit from the knowledge of tree performance under other soil types and climatic conditions. Through the diversity of climatic conditions at the various sites, it should be possible to expose the trees to a wide range of test conditions in a relatively short period of time.

Results of an earlier NC-140 cooperative interstem planting have been published (11, 16). The test plantings reported here were established in 1980 to compare the performance of 9 different rootstocks with a common scion cultivar in 27 apple producing areas of the United States and Canada. Since one of the new rootstocks in the planting (MARK or MAC 9) is being made commercially available, the committee considered it prudent to summarize the early information recognizing that additional years of testing will be necessary to fully evaluate these rootstocks.

[1]Cooperators shown in Table 1. Appreciation is extended to Oregon Rootstock, Inc., Woodburn, Oregon 97071, for propagating and furnishing trees for the planting and to the International Dwarf Fruit Tree Association for shipping expenses. Special thanks are extended to Bert Bishop, Ohio State University, for developing the statistical analysis of the data.

Materials and Methods

Trees for this planting were propagated by Oregon Rootstock, Inc., using virus-free 'Starkspur Supreme Delicious,' a spur-type strain, as the scion. The following rootstocks were included in the trial: Ottawa 3, M.7 EMLA, M.9 EMLA, M.26 EMLA, M.27 EMLA, M.9, MAC 9, MAC 24, and OAR 1. The rootstocks designated EMLA were derived from rootstocks of EMLA status (5) that were free of known viruses. Ten pollenizer trees each of 'Macspur'/M.26 and 'Starkspur Golden Delicious'/M.26 were also included. With limited amounts of some of the rootstocks, 5 replications were planted in 1980 with 5 additional replications planted in 1981. The following locations received no trees in 1980 and 10 replications in 1981: MO, UT, NC, MT, SC, TN, CO. Cooperators and locations are shown in Table 1. The trees were planted according to an individually randomized planting plan supplied by NC-140 at a spacing of 3.5 m x 5.5 m. Care was taken to ensure 5-7 cm of rootstock remained above the final soil line and all trees were headed at 70 cm. Trees were trained to a central leader system with irrigation, herbicide and fertilizers applied according to local recommendations. Since anchorage was unknown, half of the replications in each planting were left unsupported while the other half were supported by a post at each tree tied at 1 m.

The following data were collected annually and summarized at a central location: trunk circumference, number of root suckers, tree height, tree spread, total yield/tree and average weight of 50 fruit. Each site also submitted monthly air and soil temperature extremes, rainfall and light values.

Results and Discussion

The planting in NY was lost the first year due to severe vole damage. In subsequent years severe winter injury eliminated the plantings in MN and MT. The MT planting sustained considerable loss during the summer of 1981, but little further loss occurred until the winter of 1983-1984, when air temperature reached a minimum of -36.5°C in December. Tree loss generally consisted of death of the scion following injury to the graft union. The greatest loss at this time was to trees on M.7 EMLA, of which 75% of the scions were killed. Survival was greatest in trees on M.9 EMLA, M.9, Ottawa 3, MAC 9, M.26 EMLA, and OAR 1.

The MN planting suffered severe winter injury in 1983-84. The lowest temperature recorded was -35°C. on December 19. Removal of the MN planting showed none of the rootstocks had died because of the winter temperatures. However, the scion cultivar was heavily damaged and most were dead by spring 1985 when the planting was removed. A summary of losses from other plantings shows the greatest loss (30%) occurred with Ott 3 followed by M.27 EMLA (24.8%), M.9 EMLA (20.8%) and MAC 24 (16.8%) with less than 10% death of trees on other rootstocks (Tables 2 & 3). The trees on Ott 3 had sparse rootsystems when received from the nursery and most of the loss occurred in the first season. Previous reports (4, 12) have indicated that this stock propagates rather poorly. This factor may have contributed to early tree loss with this rootstock. Recent losses in Ohio appear to have collar rot or crown winter injury symptoms, although Cummins and Aldwinckle (4) class Ott 3 as resistant to collar rot. Greater tree loss occurred on trees planted in 1981 than those planted in 1980 (Table 3). Most of this loss could be attributed to sparse rootsystems and rather poor growth made in the nursery by many of these trees. MA reported no tree loss while GA, QUE, CA, KY, IN and KS had sustained the greatest losses. In AR loss of 13 of the 18 trees was attributed to apple measles. The greatest losses were manifest on the most

Table 1. Cooperators and site locations in the NC-140 apple rootstock trial established in 1980-81.

State	Cooperator	Planting Location
AR	Roy C. Rom	Fayetteville
CA	Warren C. Micke	Watsonville
CO	Kenneth S. Yu	Hotchkiss
GA	Stephen C. Myers	Blairsville
IL	Roy K. Simons	Urbana
IN	Richard Hayden	West Lafayette
IA	Paul Damoto	Ames
KS	Frank Morrison	Manhattan
KY	Gerald R. Brown	Princeton
MA	Wesley R. Autio	Belchertown
MI	Ronald L. Perry	Clarksville
MN	Emily E. Hoover	St. Paul
MO	Michele R. Warmund	Columbia
MT	Nancy W. Callan	Corvallis
NC	Eric Young	Raleigh
NY	James N. Cummins	Geneva
OH	David C. Ferree	Wooster
OR	Porter Lombard	Corvallis
ONT	Donald C. Elfying	Simcoe
PA	Loren D. Tukey	University Park
QUE	Raymond L. Granger	St. Jean
SC	Donald C. Coston	Clemson
TN	Charles A. Mullins	Crossville
UT	David R. Walker	Farmington
VA	John A. Barden	Blacksburg
WA	Bruce H. Barritt	Wenatchee
WI	Elden J. Stang	Sturgeon Bay

dwarfing rootstocks and demonstrates a potential problem when a susceptible scion is used on these stocks.

Trees on M.27 EMLA were the smallest in the trial and trees on MAC 24 the largest, as judged by trunk cross-sectional area (TCA) (Table 4). Trees on M.7 EMLA and OAR 1 were similar in size, being approximately 35-40% smaller in TCA than trees on MAC 24. Trees on M.26 EMLA were slightly larger in TCA than trees on M.9 and MAC 9. Trees on M.9 EMLA, M.9 and MAC 9 were not significantly different in TCA. Initial reports (1, 13, 15) indicated that M.9 EMLA may be much more vigorous (50%) compared to M.9 with a portion of the difference attributed to clonal variation, the remainder caused by virus effects. The similarity in size in this trial may have been due to the spur type scion cultivar, condition of the M.9 material in regard to viruses, or normal variability. Van Oosten (17) found that in one trial, trees on M.9 clones T.33, N.19 and N.25 were more vigorous and productive than trees on T.338 or M.9 EMLA, but in a later trial no differences were noted.

In 1985, with trees on all rootstocks finally reaching significant production, yield/tree closely paralleled tree size. Trees on MAC 9 had the greatest yield efficiency as judged by yield per unit TCA in 1984. Trees on OAR 1 and MAC 24 have been very slow to begin fruiting and being rather large in size, had numerically the lowest yield efficiency of any of the rootstocks. Re-

Table 2. Yield and growth of unstaked 'Starkspur Supreme' apple on 9 rootstocks in the 1980-81 uniform rootstock planting.

Rootstock	Total Tree loss (%)	1985 Suckers/ tree	1985 Trunk Area cm²	1985 Tree height cm	1985 Tree spread cm	Yield/tree (Kg) 1983	Yield/tree (Kg) 1984	Yield/tree (Kg) 1985	Cum.* Yld. Effic. (kg/cm²)
Ott-3	30.4	2.0bc	19.5cd	228bc	207bc	1.8	9.3	18.5ab	1.38a
M.7 EMLA	8.0	8.9bc	37.8b	307ab	248ab	2.1	11.0	28.2a	.94abc
M.9 EMLA	20.8	.5c	17.9cde	221c	202bc	2.3	8.3	17.0ab	1.38a
M.26 EMLA	7.6	2.1bc	25.8c	267bc	219bc	2.4	8.6	21.2ab	1.16ab
M.27 EMLA	24.8	.8bc	7.4e	141d	91d	.8	2.8	4.8c	1.46a
M.9	9.6	1.9bc	13.5de	210cd	181bc	2.8	7.1	13.1bc	1.37a
MAC 24	16.8	35.7a	64.6a	345a	295a	2.3	11.9	27.2a	.50bc
OAR 1	8.0	6.3bc	42.8b	301ab	214bc	1.0	6.0	12.3bc	.45c

*Cumulative yield (1983 through 1985) ÷ trunk cross-sectional area.

Table 3. Number of trees lost through 1985 of 'Starkspur Supreme Delicious' on 9 rootstocks in the NC-140, 1980-81 uniform rootstock planting*.

State Planted 1980	O-31	M.7 EMLA	M.9 EMLA	M.26 EMLA	M.27 EMLA	M.9	MAC 9	MAC 24	OAR 1	Total
AR	0	0	0	0	0	0	0	0	0	0
CA	2	0	0	1	8	0	0	1	1	13
GA	8	0	4	2	4	2	3	3	0	26
IL	1	0	1	0	1	0	0	2	0	5
IN	2	0	2	1	2	0	1	3	0	11
IA	0	0	0	1	0	0	0	0	1	2
KS	0	1	4	0	3	2	1	0	0	11
KY	2	1	2	0	0	2	1	3	1	12
MA	0	0	0	0	0	0	0	0	0	0
MI	3	1	0	0	0	0	0	3	0	7
OH	0	1	0	0	3	1	0	0	0	5
OR	0	0	0	0	0	1	0	0	0	1
ONT	1	0	1	0	0	0	0	0	0	2
PA	1	0	0	0	0	0	0	1	0	2
QUE	5	1	3	0	0	0	0	4	3	16
VA	0	0	1	0	0	0	0	0	0	1
WA	1	0	0	0	0	0	0	0	0	1
WI	2	0	0	0	1	0	0	1	0	4
Total	28	5	18	5	22	8	6	21	6	
Planted 1981										
MO	5	1	7	2	7	3	6	2	1	34
UT	9	2	2	1	4	0	1	6	0	25
NC	5	0	5	2	3	4	1	0	0	20
MT	8	8	5	4	9	1	2	6	4	47
SC	8	0	5	1	3	5	1	0	1	24
TN	2	0	5	0	5	1	1	0	2	16
CO	10	4	4	2	4	0	0	4	5	33
Total	47	15	33	12	35	14	12	18	13	

*Each state received 10 trees of each rootstock.

Table 4. Trunk cross-sectional area (cm^2) of 'Starkspur Supreme' apple on 9 rootstocks that were unstaked in the NC-140, 1980-81 uniform rootstock planting. (1985 data.)

Site Planted 1980	Ott-3 1	M.7 EMLA	M.9 EMLA	M.26 EMLA	M.27 EMLA	M.9	MAC 9	MAC 24	OAR 1	LSD .05
AR	18.7	35.6	18.1	29.6	8.8	19.6	12.7	43.3	35.3	9.7
CA	17.0	44.7	8.1	12.8	3.6	13.2	10.6	135.2	86.4	22.4
GA	35.0	74.0	25.8	43.4	7.5	9.9	17.9	117.6	64.5	13.3
IL	30.9	52.1	21.2	34.0	5.0	18.2	24.3	67.6	57.1	20.0
IN	27.5	58.0	22.8	32.2	7.1	16.5	20.1	95.2	58.3	12.6
IA	26.7	44.5	30.3	36.7	8.9	23.7	21.8	79.4	58.7	6.9
KS	26.8	59.0	30.2	33.6	5.7	16.9	11.9	139.4	149.7	40.8
KY	33.6	43.2	25.6	55.2	6.2	28.6	14.4	90.6	63.7	20.1
MA	19.7	44.6	13.0	25.0	4.6	7.3	26.4	92.2	26.3	10.3
MI	13.2	32.8	14.9	19.7	5.9	11.6	14.4	41.5	31.8	5.4
OH	23.7	39.6	22.7	29.2	5.1	12.9	17.7	91.8	43.9	13.3
OR	20.0	55.3	19.1	28.6	5.9	13.9	20.7	79.4	28.2	11.1
ONT	39.0	57.7	34.8	42.9	7.7	20.1	17.8	99.0	43.9	11.4
PA	20.3	40.0	20.2	22.7	6.1	12.1	16.8	55.6	42.4	7.1
QUE	8.8	23.6	10.7	14.1	4.2	8.8	14.8	34.6	19.1	8.0
VA	18.2	43.1	15.8	24.8	5.6	14.5	16.8	93.8	48.7	9.4
WA	11.3	21.7	6.7	9.6	5.4	4.7	7.9	43.6	15.4	8.2
WI	17.8	52.5	28.9	37.6	6.8	16.2	27.1	88.8	45.2	7.4
Planted 1981										
MO	19.6	25.9	10.1	22.8	6.0	10.4	19.5	28.9	36.1	7.7
UT	—	39.4	25.5	26.5	5.9	19.4	15.2	35.8	41.9	8.6
NC	13.0	35.3	10.4	23.8	1.5	9.2	5.6	60.9	38.9	21.0
SC	—	33.0	16.6	22.6	2.8	14.7	6.7	47.9	40.0	8.0
MT	7.3	15.6	7.9	15.3	4.7	7.2	12.4	19.5	12.3	NS
TN	16.3	33.6	23.1	33.5	4.9	10.9	16.9	33.4	33.4	11.5
CO	—	13.7	10.0	11.6	4.3	6.0	11.4	15.8	13.2	NS

cent reports (7, 8, 9, 10) indicate that fruit from mature trees on OAR 1 had improved color, soluble solids, firmness, lower levels of mineral content and delayed ethylene development compared to fruit from seedling, M.1, MM.106, M.7 and M.26. However, fruit from trees on OAR 1 were also 10% smaller than on the other rootstocks. Comparative yields from this trial (9) over a 6-year period showed that trees on OAR 1 produced 22% more than trees on apple seedling with the other rootstocks responding as follows compared to seedling: M.1, 39%; M.7, 40%; MM.106, 49%; M.26, 37%. Thus, long-term production from OAR 1 was not as high as from other commercially accepted rootstocks.

A comparison of the TCA's from each site indicates that KS generally produced the largest trees (Table 4). KS also produced some of the largest trees in the previous NC-140 interstem planting (11,16). The difference was particularly pronounced with OAR 1 and may have been related to very deep fertile soil at the KS site. WA, QUE and MI generally had smaller trees than other sites. Trees on MAC 24 were particularly vigorous in CA and GA. MAC 9 and M.9 were similar in size at all sites, while MAC 9 was significantly smaller than M.26 EMLA at the following sites: AR, GA, IA, KY and ONT and not different at other sites.

Cumulative yields by rootstocks at

Table 5. Cumulative yield (kg) through 1985 of unstaked 'Starkspur Supreme' on 9 rootstocks in the NC-140, 1980-81 uniform rootstock planting (1985 data).

Site Planted 1980	Ott-3 1	M.7 EMLA	M.9 EMLA	M.26 EMLA	M.27 EMLA	M.9	MAC 9	MAC 24	OAR 1	LSD .05
AR	3.2	13.4	20.5	11.6	2.6	14.0	6.5	3.6	0.0	8.5
CA	42.7	109.6	19.2	27.2	3.0	37.4	26.2	173.6	63.0	31.2
GA	1.5	34.0	17.5	44.6	3.3	17.3	45.3	2.4	9.0	NS
IL	18.0	29.0	30.6	23.2	8.0	20.8	34.4	8.0	2.0	14.2
IN	67.5	122.2	72.5	87.7	5.6	22.4	49.8	112.4	62.6	32.5
IA	21.4	19.8	34.4	30.5	10.0	25.6	21.4	6.2	5.6	11.6
KS	61.6	84.0	64.0	5-.2	36.7	32.0	12.4	80.2	10.0	40.3
KY	24.8	40.2	22.6	35.8	6.8	13.6	20.0	30.6	9.2	13.9
MA	47.4	57.4	38.0	53.8	16.8	19.6	63.6	90.2	18.0	18.3
MI	13.0	14.2	15.0	13.6	3.6	11.8	20.6	4.2	4.8	8.2
OH	64.2	41.7	47.4	36.6	9.0	27.5	36.0	94.4	23.4	25.9
OR	58.0	120.0	61.4	80.6	13.4	43.2	74.0	139.2	60.2	33.6
ONT	73.2	81.8	76.0	74.6	19.8	44.2	53.4	74.2	48.6	18.2
PA	10.8	10.2	8.8	16.0	1.2	7.2	10.6	2.6	7.4	6.1
QUE	29.5	6.8	13.8	12.4	9.0	8.2	12.8	8.5	4.7	NS
VA	47.4	67.2	42.7	50.2	12.7	34.8	44.8	79.2	29.4	18.9
WA	10.4	5.6	3.8	4.4	.8	2.0	3.2	.6	4.8	5.6
WI	28.4	56.8	45.2	49.0	9.8	27.6	39.2	51.0	27.2	11.3
Average	34.6	50.7	35.5	39.0	9.5	22.7	31.9	53.4	21.6	
Planted 1981										
MO	4.2	.2	4.0	4.2	5.0	2.3	4.6	0.0	0.0	4.5
UT	0.0	2.0	5.2	4.2	3.0	6.2	11.8	0.0	0.0	4.3
NC	6.0	14.6	5.0	5.3	0.0	2.0	3.2	1.4	2.2	4.6
MT	0.0	0.0	.3	.3	0.0	.3	0.0	0.0	0.0	NS
SC	0.0	25.7	3.6	26.0	2.6	23.5	5.0	15.9	14.0	
TN	4.6	3.6	4.6	4.6	3.5	3.7	7.0	.6	2.2	NS
Average	4.9	24.8	8.7	19.0	6.3	22.1	5.9	12.1	16.0	

each site are shown in Table 5 with OR and ONT generally having the highest yields. WA and QUE, which had generally smaller tree size, also had lower yields. The larger rootstocks, M.7 EMLA, MAC 24 and OAR 1, appeared to be particularly productive in CA, while trees on M.9 EMLA and MAC 9 performed well in OR and MA. Generally, the yields from sites planted entirely in 1981 were very low with the exception of SC.

In the evaluation of new rootstocks, there are many pomological characteristics in addition to yield and tree size that are of commercial importance. The NC-140 committee attempted to address some of these by developing a list of both scion and rootstock characteristics (Table 6). Each cooperator rated the trees in their planting on a 1-5 scale with a value of 1 as very undesirable to a value of 5 as very desirable.

In comparing the rootstocks producing the largest trees (M.7 EMLA, MAC 24, and OAR 1) M.7 EMLA was slightly superior in the following characteristics: more desirable crotch angles of the scaffold limbs, greater ease of central leader training, and good spurriness. MAC 24 was undesirable in requiring more thinning out

Table 6. Pomological characteristics of 'Starkspur Supreme Delicious' apple on 9 rootstocks in the NC-140 regional planting established in 1980-81.

Scion Characteristics	Ott. 3	M.7 EMLA	M.9 EMLA	M.26 EMLA	M.27 EMLA	M.9	MAC 9	MAC 24	OAR 1	Mean
Scaffold Limb Crotch Angles	4.2	3.8	4.2	4.2	3.8	4.0	4.2	3.2	3.2	3.8
Ease of Inducing Scaffold Limbs	3.8	4.3	3.6	4.1	2.1	3.4	3.6	4.6	4.1	3.7
Lower Scaffold Limb Dominance	3.9	3.7	3.7	3.7	3.0	3.5	3.8	3.5	3.4	3.6
Central Leader Dominance	3.5	3.9	3.1	3.8	2.3	3.2	3.5	4.1	4.0	3.5
Crown Symmetry	3.3	4.2	3.2	3.6	2.0	3.2	3.3	4.1	4.0	3.4
Trunk Leaning From Soil Line	3.2	4.2	2.8	4.0	2.7	2.6	4.0	4.6	4.6	3.9
Top of Tree Leaning	3.2	4.3	3.2	4.0	2.8	2.8	3.4	4.4	4.6	3.6
Thinning-out Pruning Needed	4.0	3.2	4.3	3.9	4.8	4.4	4.6	1.9	3.3	3.8
Water Sprout Pruning Needed	4.1	3.2	4.6	4.1	4.8	4.6	4.6	1.8	3.4	3.9
Trunk Roundness	4.1	3.9	4.1	3.6	3.7	3.9	4.0	4.4	4.5	4.0
Ease of Central Leader Training	3.4	4.2	3.1	3.7	2.0	3.0	3.3	3.6	3.9	3.3
Spurriness of Fruiting Wood	3.8	3.2	4.3	4.0	4.3	4.3	4.3	2.3	2.7	3.6
Terminal Vegetative Growth	3.3	4.2	3.0	3.5	1.7	2.8	4.3	4.0	3.3	
Time of Apical Growth Cessation	4.0	4.1	4.0	4.1	3.5	3.9	4.6	3.9	4.1	4.0
Rootstock Characteristics										
Burrknots	4.2	4.5	4.2	3.2	4.4	3.8	3.6	4.6	4.8	4.1
Surface Roots	4.6	4.7	4.6	4.4	4.4	4.3	4.1	3.9	4.7	4.4
Suckers From Root Crown	4.3	3.7	4.5	4.4	4.6	4.1	4.5	2.1	4.1	4.0
Suckers Away From Trunk	4.7	4.3	4.7	4.6	4.9	4.5	4.7	2.6	4.8	4.4
Smoothness of Graft Union	3.5	4.3	3.0	3.1	2.8	2.8	3.0	4.4	4.7	3.5

*Rating System = 1 very undesirable to 5 very desirable. Data is the average of evaluations from 20 sites.

and watersprout pruning and produced more suckers both at the crown area, as well as rootsuckers away from the tree, and had more roots exposed at the soil surface. OAR 1 generally produced a very desirable tree, with limited spurriness and tended to produce an upright growth habit.

Trees on M.27 EMLA made very little growth as a free-standing tree, were difficult to train and develop adequate fruiting scaffolds, tended to lean and lacked a smooth graft union. Combining the dwarfing characteristics of a spur type scion and the dwarfing potential of M.27 EMLA resulted in very undesirable free-standing trees.

A comparison of the other rootstocks producing smaller trees (M.9, M.9 EMLA, M.26 EMLA, MAC 9 and Ott 3) indicated that trees on M.9 and M.9 EMLA had more trunk and tree top leaning than the others (Table 6). The more vigorous trees on M.26 EMLA compared to others in this group showed a need for more pruning, and greater ease of training. Trees on MAC 9 compared favorably with M.26 EMLA in lack of leaning, verifying the improved anchorage of this rootstock compared to M.9. MAC 9 also appeared superior to others in this group in inducing growth cessation.

Although the ratings in Table 6 are subjective evaluations, the number of cooperators and sites (20 included) involved offer some validity in assessing the pomological characteristics of these rootstocks. The preference for M.7 supports long-term field experience and current recommendation of a number of research and extension personnel.

The good initial results on survivability, productivity, and desirable characteristics of MAC 9 suggest that this rootstock merits further consideration. Trees on MAC 9 appear to be better anchored than other rootstocks in this size class, which agrees with previous reports (2, 3, 14). MAC 9 with a spur habit scion produced trees very similar in size to M.9, which is smaller than previously reported with a standard habit 'Delicious' where tree size was suggested to be slightly larger than M.26 (2, 3). Dennis (6) reported that 'Red Prince Delicious' on MAC 9 trees flowered heaviest, set the largest number of fruits per cluster and per centimeter of limb circumference, and produced larger fruit than on some of the less productive MAC clones. The precocity of 'Starkspur Supreme Delicious' trees on MAC 9 was confirmed in this trial and, in fact, early productivity was so great on this rootstock that terminal growth was adversely reduced and at 5 years of age many of the trees appeared "runted out." The use of a spur type scion in this study undoubtedly accentuated this phenomena, but it is important to recognize that when combining precocious cultivars with MAC 9 adequate thinning must be accomplished on the leader and tips of permanent scaffolds to produce a good balance between vegetative growth and production. MAC 9 was named 'MARK' and patented in 1979 (14) and currently is beginning to be available to commercial growers. It is recognized that more time is needed to fully evaluate the rootstocks in this cooperative trial, but the preliminary information collected from diverse climatic areas may prove useful to those considering planting some of these newer rootstocks. It is also recognized that results relate to spur type 'Delicious' and care should be taken in predicting performance of other cultivars, particularly vigorous cultivars.

One of the original purposes of this trial was to evaluate the performance of the common rootstocks of the Malling series that had been freed of virus and released under the EMLA virus-free program (5). Initial results reported herein suggest very little difference in performance between virus-infected M.9 and virus-free M.9 EMLA, derived from mother plants of the EMLA scheme.

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Facts About Lingonberries (Cowberries, Partridgeberries)

Botany—distribution. The lingonberry plant *(Vaccinium vitis idaea)* belongs to *Ericaceae* family like the blueberries. It is a species which is boreal-circumpolar and wild growing in the forests of Scandinavia. Lingonberries are also found in Siberia, Japan and North America. A variety, *V. vitis idaea minor* or Partridgeberry, is common on Newfoundland. The plant is very hardy och drought resistant.

The lingonberry plant is a dwarf shrub with winter-green leaves, plant height about 25-30 cm. The ramified branch structure is built up by annually produced side shoots, 3-4 cm long with 5-9 leaves, where the flower buds are formed in the axils. The plant is spreading through the superficial soil layers by runners, rhizomes, which develop buds and new shoots. Gradually the shoots can cover the ground completely. The rhizomes also develop a very fine, fragile root system.

The lingonberries flower in May-June on racemes developed from the buds initiated the years before. There are 5-7 urn shaped flowers which are white to reddish, rather similar to the lowbush blueberry. The lingonberry is self-fertile and fruitset is prompted by insect pollination, mostly by bumble bees. The berries ripen in August. They are shining red, 5-7 mm in diameter with an average berry weight of 0.3 g. The seeds are very small.

Viktor Trajkovski. 1986. From Vaxtforadling Av Fruktoch bar Balsgard Verkasanhetsberattelse 1984-1985 Report, pp. 134-37.

Propagation. As pointed out above the lingonberry propagates naturally by spreading rhizomes. Cuttings or rhizomes or shoots are also easy to root and is utilized in vegetative propagation of clones, single plants, as well as meristem propagation technique.

Cultivation. The lingonberry plants thrive on soils where blueberries, *Rhododendron* and heather are grown. The soils must be low in calcium which otherwise is taken up in toxic amounts. The best conditions provide acid, (pH 4-5), light soils which are high on organic matter e.g. peat. Mulching with peat or saw dust is beneficial.

Nutrient requirements are low and one should use fertilizers recommended for *Rhododendron* or blueberries at a low dosage distributed over several times. Too high nitrogen availability will decrease flower bud formation and promote the vegetative growth. Irrigation in dry periods will also promote plant development and yield.

The weed control during the establishment of plants ought to be done manually. Hoeing must be done carefully because of the runners. Perennial weeds should be eradicated before planting.

The lingonberries are harvested by rakes similar to lowbush blueberries. Depending on growing conditions, age of plants, plant density and cultivation, the yields may be 0.3-1 kg/m^2.