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Performance of 'Starkspur Supreme Delicious' Apple Over 10 Years at Three Axillary NC-140 Planting Sites

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Abstract

A partial compliment of the 1984 NC-140 apple rootstocks were planted in axillary sites in Ohio (Ripley), Pennsylvania (Biglerville), and Missouri (Mountain Grove). The following ten rootstocks were common to the axillary sites: SDL., MAC.1, CG.24, M.4, AL.800, M.7EMLA, P.1, M.26EMLA, CG.10, P.22. The rootstocks CG.24, CG.10 and AL.800 were unique to the axillary sites. Tree loss exceeded 30% in all axillary sites for AL.800 and in OH and PA for MAC.39. CG.24 and CG.10 had high loss in MO (60%) and OH (40%), respectively. CG.24 trees were similar in size to SDL. in all axillary sites. AL.800 was similar in size to SDL. in OH. but in PA and MO they were similar to M.7EMLA. CG.10 trees were similar in size to M.26EMLA in OH, but were smaller in PA and MO. CG.24 and AL.800 had cumulative yield and efficiency similar to SDL. in all axillary sites. CG.10 cumulative yield was similar to SDL. in OH, but lower in PA and MO. Yield efficiency of CG.10 was high in all axillary sites, similar to M.26EMLA.

A premise of NC-140 apple rootstock research is the important need for evaluating scion/rootstock combinations across diverse climatic regions. Common genetic material and cultural practices allows a comparison of results from many cooperators. Adaptation to unique environments and growing regions can be determined in this manner of experimentation. The 1984 NC-140 apple rootstock cooperators were in 31 sites in North America and compared 15 different rootstocks with 'Starkspur Supreme Delicious' as the common scion. Rootstocks CG.24, CG.10 and AL.800 were either dropped because of inconsistent tree size or not included in the main study. These are unique to the axillary plantings.

Materials and Methods

Three sites did not have a full compliment of the 1984 NC-140 apple rootstocks. These were Ohio (Ripley), Pennsylvania (Biglerville), and Missouri (Mountain Grove). These axillary sites had 16, 15 and 12 different rootstocks, respectively. 'Starkspur Supreme Delicious' was the common scion. Experimental design and cultural practices were the same as the cooperative NC-140 planting sites (4). The following data were recorded for each planting: tree loss, trunk cross sectional area,

relative size, tree height and spread, trees with some suckers, cumulative yield per tree and efficiency. Sucker number per tree per year, internal bark necrosis, fruit size, and flower clusters per tree were reported for some of the plantings. Different rootstocks and numbers did not allow a combined statistical analysis. Their performance were individually compared to the cooperative plantings.

Results and Discussion

AL.800 and MAC.39 had consistently high tree loss across the axillary sites. A previous study also reported high tree loss on AL.800 (2). Of the small trees, P.22 had high loss, similar to the results of the larger NC-140 trial (4, 5). In the cooperative sites, MAC.39 and P.22 (4), and M.4. M.26EMLA, P.2 and P.16 (5) had high loss. MO had high tree loss on CG.24, M.26EMLA and B.491. Soil at this location is typical of the Ozark plateau region, a shallow silty-clay loam topsoil underlain by a fragipan. Effective rooting depth is one to two feet. Rootstocks that produce moderate to large trees such as SDL., MAC.1, M.4, MM.111, M.7EMLA. and P.1 have been free standing at this location. SDL., P.18, MAC.1, M.7EMLA, and P.1 showed good tree survival in axillary and cooperator sites (5).

Ten rootstocks were common to the axillary sites (SDL., MAC.1, CG.24, M.4, AL.800. M.7EMLA, P.1, M.26EMLA, CG.10, P.22). OH had the highest average TCA at 132 cm,[2] PA intermediate at 122 cm,[2] and MO lowest at 106 cm.[2] Comparing tree height for these same rootstocks, OH had the highest average at 3.72 m, MO intermediate at 3.63 m, and PA lowest at 3.59 m. This was only a 0.13 m range in height. Likely, these differences could be related to the soil and climate of the individual sites. Seven of the ten rootstocks were common to the cooperative sites (SDL., MAC.1, M.4, M.7EMLA, P.1, M.26EMLA, P.22). Average TCA's for these seven were 127, 125, 110 and 105 cm^2 for the

Table 1. Performance of 'Starkspur Supreme Delicious' over 10 years on 16 rootstocks established as an axillary NC-140 planting at the Southern Branch of OARDC at Ripley, Ohio.

Rootstock	Tree loss %	1993 TCA (cm^2)	Relative size (%)	1993 Tree size		Trees with some suckers (%)	Internal bark necrosis	1988-93 Cumulative	
				Height (m)	Spread (m)			Yield/tree (kg)	Efficiency (kg/cm^2)
SDL	0	181a[z]	100	4.3ab	4.4a-d	90	4.2d[y]	319b-d	1.76i-k
P.18	20	180a	99	4.2a-c	4.6a-c	50	4.6b-d	421a	2.33f-j
CG.24	10	179a	98	4.3ab	4.5a-c	80	4.2d	328a-d	1.83h-k
B.490	40	173a	95	4.3a-c	4.5a-c	55	4.5a-d	339a-c	1.96g-k
AL.800	40	165ab	91	4.1a-d	4.5a-c	40	4.2d	315c-e	1.91jk
MAC.1	20	146bc	80	3.8cd	4.6a-c	66	5.0a-d	341a-c	2.35e-i
M.7EMLA	10	139b-d	76	3.8b-d	4.3b-d	50	4.6b-d	328a-d	2.36e-h
M.4	10	137cd	76	4.0a-d	4.7ab	44	5.2a-c	387ab	2.81c-e
P.1	0	131cd	72	3.9b-d	4.2b-e	20	4.7b-d	328a-d	2.51d-f
M.26EMLA	10	114de	63	3.6de	4.1c-e	10	4.5cd	305b-d	2.69c-f
CG.10	40	89ef	49	3.1ef	3.7ef	0	4.7b-d	310b-d	3.51a-d
B.9	20	80f	44	2.8fg	3.3f	9	4.7a-d	231d-f	2.88a
MAC.39	30	74fg	40	3.1ef	3.9de	33	4.7b-d	248c-e	3.34ab
P.2	0	63f-h	34	2.5gh	3.3f	10	5.0a-d	207ef	3.29ab
P.16	20	50gh	27	2.5gh	2.7g	11	5.3ab	146fg	2.91a-c
P.22	20	39h	21	2.3h	2.7g	20	5.5a	91g	2.36e-g

[z]Mean separation within columns by Duncan's multiple range test (P = 0.05).
[y]1 = on internal bark necrosis, 5 = bark cracks to 10 = dead trees.

respective OH, PA, MO, and cooperative sites (4).

P.1 produced trees similar in TCA to M7.EMLA in OH and PA; however, P.1 was similar in TCA to M.26EMLA in MO. P.1 is more winter hardy than M.7EMLA which can be injured by low temperature (1, 6). M.26EMLA is the most winter hardy of the commercial Malling rootstocks, but is susceptible to collar rot and fire blight (3).

Of the three rootstocks in the axillary plantings and not in the main trial, CG.24 trees were similar in size to those on SDL. AL.800 was also similar to SDL. in OH, but in PA and MO trees on this rootstock were similar to M.7EMLA. CG.10 trees were similar in size to trees on M.26 in OH, but were smaller in PA and MO being larger than trees on P.22.

CG.24 and AL.800 had cumulative yield and efficiency similar to SDL. in all axillary sites. CG.10 cumulative yield was similar to SDL. in OH, but much lower in PA and MO. Yield efficiency of CG.10 was high in all axillary sites, similar to M.26EMLA.

In the M.26EMLA size class or smaller, only P.22 was common to the axillary and cooperative sites. It was considered similar in TCA, cumulative yield and efficiency to P.2 and P.16, but tree loss was greater for P.22 (4). Although efficiency was high, averaging 2.82 kg/cm^2 cumulative yield was low and highly variable being 7, 35 and 91 kg for the respective sites MO, PA and OH. P.2 and P.16 were in OH and PA and like the cooperative sites, their cumulative yield and efficiency were higher than for P.22.

Trees similar in TCA to M.7EMLA were on rootstocks P.1, AL.800 and M.4; those larger were on CG.24, MAC.1 and SDL. However, P.1, M.4 and MAC.1 were quite variable in the axillary sites. The cooperative sites had these latter three rootstocks.

Cumulative yield and efficiency were similar within a site but varied considerably across sites for large rootstocks (SDL., MAC.1, CG.24, M.4, AL.800, M.7EMLA, P.1) common to the axillary sites. They were highest for OH (335 kg/2.22 kg/cm^2), MO

Table 2. Performance of 'Starkspur Supreme Delicious' over 10 years on 15 rootstocks established as an axillary NC-140 planting at the Research and Extension Center at Biglerville, Pennsylvania.

Rootstock	Tree loss %	1993 TCA (cm^2)	Relative size (%)	1993 Tree size		Trees with some suckers (%)	Sucker number per tree per year	1988-93 Cumulative		Fruit size (g)	Flower clusters per tree (1987)
				Height (m)	Spread (m)			Yield/tree (kg)	Efficiency (kg/cm^2)		
MAC.1	0	194d[z]	102	4.3f	3.9fg	17a-c	79de	138c-e	0.73ab	213b-e	172b-d
P.18	0	192d	101	4.0ef	4.3g	1a	33ab	242g	1.39a-c	220b-e	120a-c
SDL	0	190d	100	4.3f	4.1fg	73f	93e	117b-d	0.66ab	201a-c	175b-d
CG.24	0	186d	98	4.3f	4.0fg	44c-e	86de	96a-d	0.54a	199ab	108ab
M.4	20	156cd	82	4.2f	3.9fg	55d-f	78de	144c-f	0.93ab	205a-d	154a-d
M.7EMLA	0	139c	73	4.2f	3.9fg	63ef	78de	142c-f	1.04ab	227de	252e
AL.800	30	127c	67	3.6d-f	3.4d-f	3ab	39a-c	149c-f	1.35a-c	203a-d	83a
P.1	0	120c	63	3.8ef	3.6ef	10ab	65b-e	196e-g	1.88b-d	222c-e	221de
Malling 20	10	73b	38	3.3c-e	3.0c-e	3ab	31ab	151d-f	2.58c-e	231e	114a-c
M.26EMLA	0	72b	38	3.0cd	2.9c-e	3ab	30a	210fg	3.11de	232e	182c-e
MAC.39	30	39ab	21	2.9b-d	2.7cd	7ab	59a-e	124b-e	3.28e	229de	115a-c
CG.10	0	30ab	16	2.7bc	2.2bc	33b-d	69c-e	75a-c	3.13e	211b-e	111a-c
P.2	10	19a	10	2.2ab	1.7ab	8ab	54a-d	89a-d	4.90fg	202a-c	91a
P.16	10	9a	5	1.6a	1.1a	12ab	72c-e	51ab	5.38g	200a-c	74a
P.22	20	10a	5	1.6a	1.0a	13ab	80de	35a	3.60ef	185a	88a

[z]Mean separation within columns by Tukey-Kramer test (P = 0.05).

Table 3. Performance of 'Starkspur Supreme Delicious' over 10 years on 12 rootstocks established as an axillary NC-140 planting at the Southwest Missouri State University, Fruit Experiment Station at Mountain Grove, Missouri.

Rootstock	Tree loss %	1993 TCA (cm^2)	Relative size (%)	1993 Tree size		Trees with some suckers (%)	Sucker number per tree per year	1988-93 Cumulative		Fruit size (g)
				Height (m)	Spread (m)			Yield/tree (kg)	Efficiency (kg/cm^2)	
MAC.1	0	171a[z]	103	4.4a	4.5ab	60	3bc	241a	2.00c-e	212ab
SDL	10	166ab	100	4.3ab	4.0a-d	79	22a	195ab	1.72de	203bc
CG.24	60	134bc	81	4.2ab	3.9b-d	53	9bc	189ab	1.93c-e	203bc
M.4	10	130c	78	4.2ab	4.4ab	60	13ab	199ab	1.94c-e	178d
MM.111	10	121cd	73	4.2ab	4.0a-d	52	6bc	188ab	2.28c-e	216.ab
AL.800	70	114c-e	69	3.9a-c	3.6d	56	2bc	165bc	1.62e	185cd
M.7EMLA	0	112c-e	67	3.8b-d	3.9b-d	73	22a	179b	2.07c-e	207bc
M.26EMLA	40	94d-f	57	3.6cd	4.2a-c	11	0c	221ab	3.41a	231a
P.1	10	86ef	52	3.5c-e	3.8cd	73	5bc	192ab	2.99ab	201bc
B.491	50	72f	43	3.3d-f	2.9e	31	6bc	118cd	2.41b-d	203bc
CG.10	20	41g	25	2.9f	3.0e	50	3bc	101d	3.36a	215ab
P.22	40	11h	7	1.5g	1.2f	33	2bc	7e	2.49bc	212ab

[z]Mean separation within columns by Duncan's multiple range test (P = 0.05).

intermediate (194 kg/2.04 kg/cm^2), and PA lowest (140 kg/1.02 kg/cm^2). For the small rootstocks (M.26EMLA, CG.10, P.22) cumulative yield and efficiency were 236 kg/2.85 kg/cm^2, 110 kg/3.09 kg/cm^2 and 107 kg/3.28 kg/cm^2 for the respective sites OH, MO and PA. In the cooperative sites that included different locations in OH (Wooster), MO (New Franklin) and PA (University Park) cumulative yield and efficiency were respectively 289 kg/3.67 kg/cm^2, 152 kg/1.57 kg/cm^2 and 112 kg/2.53 kg/cm^2 (5).

Fruit size was small from trees on rootstocks AL.800 and M.4 in MO, and on P.22 in PA. OH did not report fruit size. Cooperative sites had small fruit size on SDL., M.4 and P.22 trees, and P.18 had large size (4). In PA and MO, M.26EMLA had large fruit size. M.20 and P.18 were respectively, large and intermediate in size in PA. As with the cooperative sites, fruit size was not adjusted for crop load.

Rootstocks with a high percentage of both trees with some suckers and number per tree per year were SDL., CG.24, M.4, M.7EMLA and CG.10 in PA; and SDL., M.4 and M.7EMLA in MO. OH reported only trees with some suckers; SDL., P.18, CG.24, B.490, AL.800, MAC.1, M.7EMLA and M.4 were high. Internal bark necrosis was reported in OH; every rootstock had bark cracks present.

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