

## Performance of AL.800 as an Apple Rootstock and Interstem in Ohio

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### Abstract

AL.800, a potential rootstock identified in a commercial orchard, was propagated through tissue culture and tested in several plantings as a rootstock and interstem. Melrose scions on AL.800 were larger than on MARK. Cultivars on AL.800 tended to begin bearing a year later than on MARK, but cumulative yields after 6 years were similar. After 9 years, trees of 'Starkspur Supreme Delicious' on AL.800 were similar in size to trees on seedling, P.18, B.490, MAC.1, M.4 and M.7EMLA. Of this group, cultivars on AL.800 tended to have the lowest cumulative yield/tree and cumulative efficiency and did not differ significantly from seedling. Interstem trees on AL.800 on several rootstocks tended to be less precocious than those with B.9 interstems. Due to the difficulty of propagation by mound layering, lack of precocity and low yields and yield efficiency, AL.800 is not recommended for intensive orchards.

Growers continue to search for new rootstocks that are precocious, dwarfing, tolerant of many soil types and resistant to important rootstock diseases. Rootstocks in the original Malling series were chance seedlings which the East Malling research station collected, classified and tested (4, 9). These rootstocks are very widely planted, often in areas quite different than the maritime climate of southern England. In the United States problems occur with these rootstocks and growers continue to look for rootstocks that come closer to the ideal.

Several locations have established rootstock breeding programs and are making new releases (1). Some of the newer rootstocks introduced on breeding programs such as MARK

from Michigan, B.9 from Russia or P2 from Poland have some of the desired characteristics (2, 3, 8). However, each of these new releases appear to have some deficiencies and the search continues for new dwarfing rootstocks.

In 1974 the Lynd Fruit Farm in Pataskala, Ohio, sent rootstock material to Hilltop Nursery, Hartford, Michigan, from a tree on their farm. This material was designated AL.800 (AL-Arnold Lynd). The root and sucker material came from the root system of a 'Duchess' tree that had survived in an old orchard that was present in 1919 when the farm was purchased. Although this block of trees was removed in the late 1920's, this particular tree was retained because of its small size of approximately 10 feet, and annual productivity. This orchard included many dead trees in a weakened state which were 25 feet tall or more.

About 8 years after the block was replanted many of the trees were killed or damaged by the winter of 1936, but the old 'Duchess' tree was not injured. In 1976 the block was removed again and it was noted that over the years harsh weather and disease had taken their toll, as evident by the fact that there were trees of several different ages.

The old 'Duchess' tree was still producing, however it was in a state of low vigor with terminal growth of only 2 inches long. It was about 10 feet tall and still had a healthy trunk,

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but one of the main limbs was dying. The fruit of this tree was of no value, so no effort was made to revitalize it. The Lynd family wanted to preserve and test rootstock material from this tree for the following reasons. It was:

1. a dwarf tree (10 feet in 75 years)
2. resistant to severe midwestern weather with sudden drops in temperature.
3. free standing and never leaned
4. prospering in a wet, heavy clay soil where many other trees were infected with collar rot.

The research reported here was conducted to compare AL.800 to existing rootstocks and interstems.

### Materials and Methods

Hilltop supplied several trees of AL.800 budded on MM.106 rootstock and attempts at mound layering were not successful. AL.800, growing as a scion, exhibited relatively short internodes, and thick trunk bark characteristic of apple rootstocks that induce dwarfing (9).

AL.800 was successfully propagated by tissue culture using Hilltop-grafted trees (AL.800 on MM.106) as stock plants. Terminal branches were tipped to encourage lateral bud growth. Shoot tips 1-2 cm long were surface sterilized using 10% chlorox (0.5% NaOCl) and plated on Murashige-Skoog (MS) medium with 1 mg/l benzyladenine (7). Contamination-free explants were transferred onto fresh MS1B medium in 125 ml culture jars for shoot tip multiplication. Microcuttings were dipped in a 500 ppm solution of indolebutyric acid (IBA) and rooted aseptically in aluminum food trays containing ('Redi-Earth') a soilless medium. After approximately 4 weeks, rooted cuttings were potted and acclimated to greenhouse conditions to encourage vigorous vegetative growth. Cultivars were chip-budded onto these rootstocks for evaluation of AL.800 as a rootstock in the following experiments.

In study 1, the performance of five cultivars on AL.800 was evaluated. Study 2 compared the performance of 'Starkspur Supreme Delicious' on AL.800 and 14 other rootstocks and in study 3, the use of AL.800 as an interstem was compared to several other interstems on 4 rootstocks with 3 cultivars.

*Study 1* — In 1987 trees of each combination shown in Table 1 were planted in a fine, loamy mixed mesic typic fragiudalf soil at Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH. The trees were planted as guard rows between systems in a replicated orchard systems trial at a spacing of 4 m in the row and either 4 or 7 m between the rows in the next system. There were 6-9 trees of each combination in a completely randomized design.

*Study 2* — In 1984 'Starkspur Supreme Delicious' trees on 15 rootstocks were planted at the OARDC Southern Branch near Ripley, Ohio in a Ross moyne aquic fragiudalf, fine silty mixed mesic soil. This was a companion to the 1984 NC-140 rootstock planting at Wooster, but included AL.800 and also 'Lawspur'/AL.800 as a pollinizer. A randomized complete block design was used with 10 trees of all combinations.

*Study 3* — In 1985 trees of 'Starkspur Supreme Delicious', 'MacSpur McIntosh' and 'Granny Smith' on several interstem/rootstock combinations were planted at the OARDC Mahoning Branch near Canfield, Ohio on a Canfield silt loam aeric fragiaqualf fine-loamy mixed mesic soil. Although 12 different dwarfing interstems were included in this study, not all interstems were used with each rootstock or cultivar (Tables 3, 4, 5). The trees were planted in rows by cultivar with the rootstock/interstem combinations completely randomized. In all 3 studies, the trees were trained to a free-standing

**Table 1. Performance of several apple cultivars on 3 rootstocks, over 6 years at Wooster, Ohio.**

Cultivar	Rootstock	No. of trees	Tree size at 6 yrs (1992)			Yield/tree (kg)				Cumulative	
			area (cm <sup>2</sup> )	height m	spread m	1989	1990	1991	1992	yield/tree kg	efficiency kg/cm <sup>2</sup>
Smoothee	MARK	8	36.5cd	3.0bc	3.2bc	6.0a	10.0	18.7a	47.2a	72.2a	1.94a
Melrose	MARK	8	40.0cd	3.0bc	3.5b	1.3b	9.2	16.6ab	11.0c	29.5cde	.76bc
Smoothee	AL.800	9	51.9bc	3.5abc	3.5b	.7b	11.5	10.4abc	42.0ab	53.5ab	1.03b
Melrose	AL.800	9	72.8b	3.9a	4.4a	0.0b	15.6	10.5abc	39.7ab	50.6abc	.67bc
Mutsu	AL.800	6	95.7a	3.3abc	3.8ab	0.0b	17.1	6.7bc	15.8c	22.6de	.24d
Royal Gala	AL.800	8	56.9bc	3.8ab	3.5b	1.7b	14.2	13.8abc	22.7bc	38.4bcd	.60cd
Starkspur Supreme	AL.800	9	42.5cd	3.1abc	2.6cd	1.0b	9.6	8.3abc	14.7c	24.2de	.56cd
Starkspur Supreme	Sargent	6	23.6d	2.8c	2.0d	0.0b	5.8	4.0c	8.7c	12.7e	.57cd
Melrose	Sargent	7	43.4cd	3.3abc	3.2bc	0.0b	9.5	6.3bc	17.5c	24.0de	.57cd

\*Mean separation within columns by Duncan's Multiple Range Test, 5% level.

**Table 2. Influence of 15 rootstocks on tree size and yield of 'Starkspur Supreme Delicious' over 9 years in the NC-140 planting in Southern Ohio.**

Rootstocks	No. of trees	Relative size (%)	TCA 92 (cm <sup>2</sup> )	Yield/tree (lbs)					Cumulative	
				1988	1989	1990	191	1992	yield (lbs)	efficiency (lbs/cm <sup>2</sup> )
Seedling	10	100	156.7abc	7.0fg	24.0bcd	62.7defg	193.8ab	104.8bcd	400.4cd	2.52hi
P.18	10	102	160.9ab	10.4efg	77.1abc	91.6bcd	230.4ab	136.7b	549.7ab	3.22efg
B.490	9	95	149.7abcd	10.3efg	53.1defg	64.1defg	167.4abc	138.0ab	416.9bcd	2.70fgh
AL.800	5	87	136.5abcde	1.7g	72.2abc	40.4fg	130.8cde	73.5bcdef	267.5def	1.94i
MAC.1	3	82	129.0cde	10.2efg	14.6cd	81.1bcde	193.8abc	90.3bcde	420.8bcd	3.16efgh
M.4	9	82	129.1cde	7.4fg	56.9abcd	85.6bcde	242.6a	113.1bcd	486.7bc	3.71cdef
M.7EMLA	10	78	122.6de	11.5efg	67.3abcd	58.9defg	188.6abc	126.8bc	432.4bcd	3.42defgh
P.1	10	74	116.4ef	23.7bcd	39.5abcd	97.3b	180.0bcd	77.5bcdef	419.6bcd	3.65cdefg
M.26EMLA	9	69	109.3efg	15.0defg	71.4abcd	106.4b	178.0bcd	59.8cdefg	403.2cd	3.72cdef
CG.10	9	49	78.2hi	19.4bcdef	72.1abc	62.3defg	136.8cde	62.3cdef	397.9cd	4.45bcd
B.9	8	45	71.4hij	26.8bc	60.1abcd	72.9cdef	123.8def	64.5cdefg	344.1cd	5.92a
MAC.39	8	42	66.5hij	9.0fg	33.0bcd	72.4cdef	139.2cde	52.0defg	304.1de	4.45bcd
P.2	10	36	57.4ijk	14.8defg	45.0abcd	86.2bcde	119.0def	20.9efg	283.3de	4.98b
P.16	8	28	44.5jk	14.5defg	29.5bcd	44.5fg	72.2fgh	14.9fgh	179.2ef	4.61bc
P.22	9	21	33.6k	10.4efg	13.0cd	39.6g	49.3h	10.7g	122.7f	3.78cdef
<b>Pollenizers</b>										
Macspur/M.26	8	88	138.7abcde	31.0ab	78.9abc	90.4bcde	66.3gh	88.5bcde	375.4cd	2.58ghi
Gol.Del./M.26	9	57	90.8fgh	41.6a	102.2a	138.5a	131.1cde	205.8a	663.6a	6.57a
Lawspar/AL.800	9	53	82.7ghi	26.4bcd	85.8ab	97.3bc	113.6efg	54.1defg	378.2cd	4.08bcde

Mean separation within columns by Duncan's multiple range test, 5% level.

**Table 3. Performance of selected interstems on four rootstocks on early growth and productivity of 'Starkspur Supreme' trees planted in 1985.**

Rootstocks	Interstem	No. of trees	Yield/tree (lbs)				TCA cm <sup>2</sup> 92	Cumulative	
			89	90	91	92		lbs/tree	lbs/cm <sup>2</sup>
MAC.1	C.6	8	3.2	58.7b	23.0	64.1c	32.7b	173.8b	6.05
	AL.800	4	2.7	96.5a	37.2	136.0a	86.1a	277.2a	3.17
	B.9	6	10.5	113.8a	31.6	100.5b	46.1b	297.1a	6.74
	CG.10	6	6.0	87.0ab	38.0	78.0bc	42.3b	240.3ab	5.77
MM.106	MAC.46	4	2.7b	115.5	63.0	184.0a	106.0a	374.2	3.57c
	C.6	6	26.0a	113.8	44.3	94.1b	47.9b	346.3	7.26a
	AL.800	1	2.0b	78.0	25.0	79.0b	40.2b	184.0	4.56bc
	CG.10	5	8.0ab	101.0	24.2	100.6	45.4	286.2	6.24ab
MM.111	AL.800	3	1.6	74.0	21.3	78.6	60.3	176.7	2.94
	B.9	5	7.2	81.0	29.2	81.4	40.3	220.8	4.92
M.4	MAC.39	7	4.4b	77.2b	21.1	63.2	34.1b	188.4b	5.51ab
	AL.800	4	7.6b	95.5ab	32.5	86.6	58.9a	239.0b	4.72b
	B.9	6	16.0a	134.1a	43.1	99.0	50.5a	343.1a	6.71a

Separate analysis of interstems within a rootstock and mean separation Duncan's Multiple Range P = 0.05. Means without letters nonsignificant.

**Table 4. Performance of selected interstems on four rootstocks on growth and productivity of 'Macspur' trees planted in 1985.**

Rootstocks	Interstem	No. of trees	Yield/tree (lbs)				TCA cm <sup>2</sup> 92	Cumulative	
			89	90	91	92		lbs/tree	lbs/cm <sup>2</sup>
MAC.1	P.2	6	23.8	101.4	22.2	120.0b	53.1c	287.8	4.91a
	C.6	5	27.6	101.4	28.0	191.5ab	128.9ab	394.4	3.25ab
	AL.800	5	22.6	78.0	20.0	157.8ab	151.1a	292.8	2.14b
	B.9	4	43.0	105.6	29.2	115.8b	92.4bc	394.0	4.63a
	CG.10	6	33.6	121.3	15.8	221.0a	93.0bc	412.0	4.47b
MM.106	P.22	6	16.8b	39.1c	10.6b	32.6d	22.1c	215.2c	9.66a
	MAC.46	5	41.8ab	69.6bc	40.6ab	213.0ab	160.3a	391.8bc	2.49c
	C.6	7	56.2ab	123.3b	43.3ab	180.7abc	102.3ab	448.4bc	4.41bc
	MAC.9	5	45.6ab	102.2b	16.8b	123.2bc	56.9bc	371.0bc	6.84ab
	AL.800	1	66.0a	293.0a	78.0a	271.0a	142.3a	733.0a	5.14bc
	CG.10	4	57.5ab	138.5b	23.2b	187.2abc	81.4abc	545.2ab	6.73ab
MM.111	B.491	5	41.6ab	90.2bc	34.6b	113.4cd	104.7ab	329.2bc	5.00bc
	--	10	22.8	51.3ab	23.1	188.8a	139.9	290.6	2.08b
	AL.800	3	19.0	28.0b	11.0	17.0b	75.9	183.0	2.40ab
	B.9	5	37.2	99.0a	14.8	159.6a	64.9	414.8	5.85a
	B.491	9	13.1	51.5ab	17.3	118.7ab	78.5	189.1	3.31ab
M.4	M.20	6	23.3	52.6ab	18.6	112.5ab	63.6	277.7	5.25ab
	P.1	6	54.1a	108.8ab	23.8ab	201.6a	157.8a	432.5ab	2.78b
	P.2	4	19.6b	46.0b	18.0ab	38.7b	31.3c	202.0c	6.90a
	MAC.39	7	29.5ab	63.8ab	9.7b	125.2ab	92.1abc	298.8bc	5.19ab
	C.6	5	55.2a	113.0ab	31.0ab	156.2a	82.2bc	469.4ab	5.92a
	AL.800	4	18.7b	59.5b	34.6a	186.7a	140.4ab	388.6ab	2.74b
B.9	6	49.3ab	147.3a	21.8ab	213.6a	104.7ab	515.5a	5.04ab	

Separate analysis of interstems within a rootstock and mean separation Duncan's Multiple Range P = 0.05. Means without letters nonsignificant.

central leader system with minimal pruning. Trunk circumference and yield were collected annually in each trial.

### Results and Discussion

**Study 1** — ‘Melrose’ trees on AL.800 rootstocks were larger than ‘Melrose’ on either MARK or Sargent (Table 1). Although trees of ‘Smoothie’ or ‘Starkspur Supreme’ tended to be larger on AL.800 than on MARK or Sargent, respectively, the differences were not statistically significant. Trees on AL.800 tended to begin bearing a year later than on MARK. However, cumulative yield of the 2 cultivars in common on MARK and AL.800 were not different after 6 years. Trees on Sargent were also slow in coming into bearing and tended to have lower cumulative yields than trees on AL.800, although the difference was significant only with ‘Melrose.’ Cumulative yield efficiency of ‘Smoothie’/AL.800 trees was lower

compared to MARK, but there were no differences in efficiency of ‘Melrose.’

**Study 2** — Trees of ‘Starkspur Supreme Delicious’ on AL.800 were similar in size to trees on seedling, P.18, B.490, MAC.1, M.4 and M.7EMLA (Table 2). Of this group, trees on AL.800 tended to have the lowest cumulative yield/tree and cumulative efficiency, and did not differ significantly from that of seedlings. Results of a companion study in Pennsylvania indicated that ‘Starkspur Supreme’/AL.800 trees were about 67% the size of apple seedling, trees were slow to begin bearing and did not differ significantly from trees on seedling rootstock in yield or efficiency (5,6). Tree loss of AL.800 was 30% in PA and 50% in the OH trial. Root suckering on AL.800 was minimal at both locations.

Of the 6 rootstocks smaller than M.26, trees on CG.10, B.9, MAC.39 and P.2 were similar in size with trees

**Table 5. Performance of selected interstems on four rootstocks on growth and productivity of ‘Granny Smith’ trees planted in 1985.**

Rootstocks	Interstem	No. of trees	Yield/tree (lbs)				TCA cm <sup>2</sup> 92	Cumulative	
			89	90	91	92		lbs/tree	lbs/cm <sup>2</sup>
MAC.1	P.2	2	10.0ab	58.4bc	32.4ab	43.1b	40.9bc	217.2	5.05b
	C.6	5	12.6ab	97.8ab	40.4a	54.6b	33.0b	251.2	3.44b
	AL.800	5	2.8b	134.2a	55.2a	98.2a	118.7a	343.4	3.14b
	CG.10	6	18.6a	97.1ab	47.3a	66.0ab	74.8b	330.3	4.80ab
	M.20	4	9.5ab	32.0c	9.6b	27.2b	17.4c	182.0	10.40a
MM.106	P.22	5	16.0	47.0b	10.0b	33.0b	20.9c	222.8	9.95a
	MAC.46	6	21.8	168.0a	102.0a	133.6a	113.6a	519.7	4.07ab
	C.6	6	23.3	83.0ab	36.0b	64.1b	53.5b	327.8	6.05ab
	MAC.9	6	23.6	130.0ab	31.0b	75.5ab	59.3b	332.7	5.14ab
	AL.800	3	22.6	134.0ab	100.0a	134.0a	122.9a	520.0	4.12b
	CG.10	6	31.6	92.0ab	47.0b	81.8ab	53.1b	358.8	6.76ab
	B.491	5	22.6	97.0ab	30.0b	73.2ab	28.3c	284.8	9.15ab
M.20	5	21.6	61.0ab	34.0b	43.0b	38.1c	290.6	9.17ab	
MM.111	AL.800	3	7.6b	91.6	53.3	78.2	88.5ab	312.0	3.72
	B.9	6	21.3	70.8	30.8	69.0	44.6bc	256.7	5.48
	B.491	9	6.0b	78.5	46.8	64.7	92.6a	295.3	4.60
	M.20	6	7.8b	36.8	16.0	31.3	30.9c	214.2	10.43
M.4	P.2	4	12.5	48.0b	14.3b	59.3	32.0	267.0	8.63
	MAC.39	8	11.3	97.4a	37.2a	76.1	52.2	361.6	7.19

Separate analysis of interstems within a rootstock and mean separation Duncan's Multiple Range  $P = 0.05$ . Means without letters nonsignificant.

on P.16 and P.22 generally smaller. The cumulative efficiency of trees on B.9 was superior to all other rootstocks and was due to higher yields in 1988 and consistently high production the other years. B.9 has been productive at most sites in the NC-140 trial (8) and in other trials in Ohio (3).

A number of the 'MacSpur' trees in this trial had reverted to standard habit 'McIntosh,' resulting in the larger tree size. Tree size of 'Lawspur'/AL.800 and 'Golden Delicious'/M.26 were similar, but 'Golden Delicious'/M.26 had higher yields/tree and greater production efficiency.

*Study 3* — Although the differences were not always statistically significant, B.9 interstem trees tended to be precocious and AL.800 tended to be non-precocious with 'Starkspur Supreme' (Table 3), 'MacSpur' (Table 4), and 'Granny Smith' (Table 5). The only clear exception was AL.800 interstems on MM.106. On MAC.1 rootstocks, interstem trees of AL.800 were larger than interstem trees of B.9 with both 'Starkspur Supreme' and 'MacSpur'; however, trees on these interstems did not differ whether they were on MM.111 or M.4 rootstocks. MAC.46, as a rootstock, produced a large tree (3) and also appeared to result in a large tree when used as an interstem and has low production efficiency similar to AL.800. C.6, as an interstem, tended to produce slightly smaller trees than interstems of AL.800 and tended to have greater cumulative efficiencies,

but differences were not usually statistically significant.

AL.800, as a rootstock or interstem, appears to result in a relatively large tree, only slightly smaller than apple seedling and larger than M.7. These results suggest that it is not precocious and since it is difficult to propagate by conventional stool layering, AL.800 does not have promise as a rootstock for intensive orchards.

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## Cherry Rootstocks on Flowering and Fruiting

Edabriz rootstock increased the number of flowers per spur, increased spurs, and resulted in higher yields with smaller fruit and a reduced fruit set of 'Burlat' sweet cherry compared to the standard rootstock, F 12/1. One year old branch Sections had more flowers and fruit, and larger fruit size compared to older branch portions. From: Kappel and Lichou. 1994. *HortScience* 29:611-612.



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### Harvest Date on Pecan Flavor

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