

Rootstock Studies with Peach and *Prunus subcordata* Benth.¹

A. N. ROBERTS AND M. N. WESTWOOD²

Abstract

The first study was with clones of *Prunus subcordata* Benth. on seedling roots of peach, myrobalan plum, Marianna plum, and *P. americana* Marsh. After four years, trees on peach root were the largest and those of *P. americana* were smallest; however after 10 years the trees on all of the plum stocks were larger than those on peach. Fruit yield per tree and yield efficiency after 10 years was somewhat better on peach and *P. americana* than on myrobalan or Marianna roots.

The second study was with peach cultivars on rootstocks of peach and several types of plum, with interstems of *P. subcordata* clones and of Yellow Kroos plum. Tree size was largest with peach and St. Julien A roots and smallest with *P. tomentosa* Thunb. and Myrobalan B plum. Tree size as related to *P. subcordata* interstems was largest with L-IX clone and smallest with K-I clone. Yield efficiency was highest for peach and *P. americana* rootstocks and lowest for Myrobalan B. Mineral nutrient content of peach leaves was generally high with peach and St. Julien A stocks and notably low with Marianna.

Peach trees are usually grown on peach seedling rootstocks, but plum species sometimes have been used (1, 3, 4, 6, 7). Tukey (9) reported that Krujespruin or Yellow Kroos (*Prunus insittia* (L.) Bullace) is a better stock for peach than Blue Kroos but that the trees tend to be late coming into bearing. Gibson (4) reported also that Yellow Kroos stock was better than peach in wet soils. Several researchers (1, 3, 7) have found that Marianna rootstocks (*P. cerasifera* x *P. munsoniana*?) are usually not graft compatible with peach scions. McClintock (7) reported that this incompatibility was due to failure of phloem to unite at the union. Later supporting evidence for this was found by Breen and Muraoke (1) in a study of reciprocal grafts of peach and Mari-

anna 2624, in which plum/peach was compatible but peach/plum was not. In the latter case, leaf levels of N, P, K, Ca, and Mg were lower in August than those of healthy trees, and the levels of inositol and of P, K, Mg, and Ca in scion bark were much higher just above the union than below it, indicating phloem blockage. Day (3) reported that in only a few cases were seedlings of myrobalan (*P. cerasifera* Ehrh.), Marianna, *P. hortulana* Bailey, and *P. angustifolia* compatible enough for long-term survival. Those he listed as nominally satisfactory for peach were apricot (*P. armeniaca* L.), St. Julien (*P. insittia* (L.) Bullace) and Brompton (*P. domestica*). E. L. Reeves (personal communication, 1960) reported that three varieties of peach and two of apricot grew poorly when budded high on *P. subcordata* rootstocks, but two plum and two almond varieties similarly budded grew and cropped very well.

While considerable information is available on the suitability of rootstocks for many plums (1, 2, 3, 5), little attention has been given to stocks suitable for the native Pacific plum, *Prunus subcordata* Benth. (3, 8). There is continuing interest in using selections of this species in home orchards and small commercial plantings for fruit in making preserves, as well as for dwarfing interstocks in peach propagation. *P. subcordata* seedlings in general have proved undesirable as rootstocks because of suckering and poor transplant survival.

On the basis of observations made in semi-commercial orchards near Lakeview and Medford, Oregon, and

¹Oregon Ag. Exp. Sta. Tech. Paper 5620.

²Dept. of Horticulture, Oregon State Univ., Corvallis 97331.

performance data in nurseries and young orchards at the Lewis-Brown Horticulture Research Farm near Corvallis from 1944-50 (8), it was decided in 1950 to compare seedlings of peach (Lovell seedlings) myrobalan plum (*Prunus cerasifera* Ehrh.), Marianna plum (*P. cerasifera* x *P. munsoniana*?) and *P. americana* as rootstocks for this species.

A second study was initiated in 1955 to find satisfactory growth control of peach trees using interstems of *P. subcordata* and Yellow Kroos plum and to evaluate such interstems as compatibility bridges between peach scions and several *Prunus* rootstocks.

Test 1 — Rootstock for *P. subcordata* varieties:

Materials and Methods

Seedlings of the above species were obtained from commercial nurseries during the winter of 1947 and spring of 1948, and lined-out for budding to 9 variety selections of *P. subcordata* (Lake County (L) I, II, III, IV, VA, IX, X and Klamath County (K) I) described in the above cited bulletin. The trees were grown as unbranched whips in the nursery and orchard planted the spring of 1950. The one-acre orchard consisted of 3-tree, variety blocks consisting of one variety on each of the 3-rootstocks. These variety blocks were replicated three times at random in the orchard giving a total of three trees of each variety/rootstock combination.

The orchard was maintained over a 10-year period and record made in some years of trunk circumference, flowering date, tendency for rootstock suckering, and tree height and spread. Fruit yields were recorded each year.

Results

Tree growth during the first four years varied not only among the rootstocks used, but also varied with the different scion selections of *P. subcor-*

data (Table 1). There was also a great deal of tree-to-tree variability, which probably was due largely to the genetic variability of the seedling rootstocks. In general the largest trees were on peach rootstock and the smallest on *P. americana*. Myrobalan and Marianna, closely related stocks, were usually similar in tree size. Very vigorous *P. subcordata* clones on peach rootstock were more than twice as large as other clones on peach.

Yield during the first six years varied much more from clone to clone than by rootstock, but there was extreme tree-to-tree variability which indicated genetic variability in the rootstocks (Table 2). The most vigorous rootstocks tended to be less precocious, yet there were many exceptions to this tendency.

After ten years, tree size as related to rootstock had reversed the earlier trend and trees on peach stock were then the smallest, with those on plum stocks being larger but similar to each other in size (Table 3). Yield per tree tended to be higher for the less vigorous peach stocks, and yield efficiency generally was better with peach than plum rootstocks. However, the sharp differences in yield efficiency between specific scion/rootstock combinations indicates the need for selecting rootstocks specifically for a given cultivar. For example, peach was by far the most efficient stock for L IV, and Marianna was the poorest. Yet Marianna was a very good stock for clones L II and L X.

Test 2 — Performance of peach on several rootstocks and interstocks:

Materials and Methods

One planting was made in 1955, consisting of 10 to 20 trees each of four peach cultivars on Yellow Kroos interstem and Marianna rootstock. Another planting was made in 1959-60 and consisted primarily of 5 to 15

Table 1. Trunk cross-sectional area (cm²) for several varieties of *Prunus subcordata* on four different rootstocks, at 4 years of age, 1950-53

<i>P. subcordata</i> Variety	Tree No.	Seedling rootstock:			
		Peach	Mari-anna	Myro-balan	P. amer-icana
L I	1	27.2	16.7	9.4	—
	2	18.6	10.3	10.0	—
	3	14.1	13.4	12.2	—
	Mean	20.0	13.5	10.5	—
L II	1	47.0	16.6	13.4	3.9
	2	20.0	15.4	4.1	2.5
	3	26.0	18.9	—	1.2
	Mean	31.0	17.0	7.5	2.5
L III	1	15.8	4.2	19.1	1.2
	2	27.2	33.4	13.9	5.5
	3	21.7	17.2	5.8	—
	Mean	21.6	18.3	12.9	3.4
L IV	1	14.5	19.9	11.6	—
	2	16.5	3.7	10.6	—
	3	12.8	—	11.6	—
	Mean	14.6	11.8	11.1	—
L VA	1	21.4	9.6	16.0	—
	2	20.4	20.1	7.3	—
	3	15.6	9.6	9.3	—
	Mean	19.1	13.1	10.9	—
L VI	1	18.6	15.4	9.6	—
	2	29.6	32.8	11.5	—
	3	32.8	22.2	4.6	—
	Mean	27.0	23.5	8.6	—
L X	1	23.3	25.5	40.3	2.7
	2	39.2	14.7	15.4	2.2
	3	21.7	25.8	17.9	1.3
	Mean	28.1	22.0	24.5	2.1
K I	1	15.6	3.2	15.6	—
	2	19.9	19.4	11.5	—
	3	11.8	18.4	18.1	—
	Mean	15.8	13.7	15.1	—
General Mean		22.2	16.9	12.6	2.7
Vigorous Clones*					
L XVIII		50.0			
L XIX		48.8			
L XX		45.1			
L XXI		48.5			

*Means of 3 trees each

Table 2. Cumulative fruit yield per tree, first six years, for several varieties of *P. subcordata* on four different rootstocks.

<i>P. subcordata</i> Variety	Tree No.	Seedling rootstock:			
		Peach	Mari-anna	Myro-balan	P. amer-icana
Pounds fresh weight					
L I	1	5	1	1	—
	2	5	1	2	—
	3	14	2	—	—
	Mean	8	1	2	—
L II	1	12	3	3	—
	2	16	8	—	2
	3	30	16	—	1
	Mean	19	9	3	2
L III	1	20	14	12	8
	2	14	7	12	9
	3	12	60	14	—
	Mean	15	27	13	8
L IV	1	22	17	—	—
	2	37	6	22	—
	3	4	—	14	—
	Mean	21	11	18	—
L VA	1	17	17	3	—
	3	34	5	5	—
	Mean	21	9	4	—
	L VI	1	5	1	4
2		7	0	6	—
3		—	4	1	—
Mean		6	2	4	—
L X	1	24	29	27	17
	2	10	8	25	—
	3	11	47	38	29
	Mean	15	28	30	23
K I	1	4	1	4	—
	2	4	4	4	—
	3	4	1	4	—
	Mean	4	2	4	—
General Mean		13.6	11.1	9.8	11.0
Vigorous Clones*					
L XVIII		23			
L XIX		7			
L XX		9			
L XXI		0			

*Means of 3 trees each

Table 3. Tree size (cm²), cumulative yield, and yield efficiency after 10 years of several varieties of *P. subcordata* on four different rootstocks

<i>P. subcordata</i> Variety	Seedling rootstock:			
	Peach	Mari- anna	Myro- balan	<i>P.</i> amer- icana
Trunk cross-sectional area (cm²)				
L II	72	106	121	129
L IV	54	115	78	—
L VA	87	76	54	—
L X	—	97	109	67
K I	53	72	87	—
Mean	67	93	90	98
Cumulative yield (pounds per tree)				
L II	36	45	—	18
L IV	47	12	39	—
L VA	38	9	7	—
L X	—	51	38	54
K I	25	5	18	—
Mean	37	24	26	36
Yield efficiency (lbs. per 10 cm² trunk)				
L II	5.0	4.2	—	1.4
L IV	8.7	1.0	5.0	—
L VA	4.4	1.2	1.3	—
L X	—	5.3	3.5	8.1
K I	4.7	0.7	2.1	—
Mean	5.7	2.5	3.0	4.8

trees each of Redhaven and Early Elberta on interstems of three clones of *P. subcordata* and rootstocks of Lovell peach, *P. americana* Marsh., Marianna, and Myrobalan B. A few cultivars were direct-worked to rootstocks of *P. tomentosa* Thunb., St. Julien A (*P. insititia*) and Brompton (*P. domestica*).

The trees were planted at the Lewis-Brown Horticulture Research Farm at Corvallis in chehalis silty clay loam soil of pH 6.3 at 8 foot spacing.

Although the various understock treatments were replicated, they were not randomized within the plot. For that reason statistical analyses were not done. However, the many attributes of such tree systems (dwarfing, compatibility, precocity, and longevity

were readily apparent without benefit of statistics.

Nitrogen analysis was done by a micro-kjeldahl method, and the other elements were determined by a direct-reading spark emission spectrometer. Leaf samples were taken in August from mid-portions of terminal shoots.

Results and Discussion

Striking differences are seen in both growth and yield (Table 4). The rootstock effect from large-to-small tree size was: peach > St. Julien A > *P. americana*, Marianna > *P. tomentosa*, Myrobalan B. Tree size as related to *P. subcordata* interstems on peach rootstock was L IX > L IV > K I. Interstem effects with plum rootstocks were inconsistent but trees with Yellow Kroos interstems clearly were more vigorous than those with *P. subcordata*.

Yield efficiency, i.e. yield per unit of tree size, was relatively high for peach, *P. americana* and *P. tomentosa* rootstocks, intermediate for Marianna and St. Julien A, and low for Myrobalan B (Table 4). With such extreme variation in tree size, yield efficiency is a much better estimate of yield potential than is the use of yield per tree. Spacing trials have not been done, but we estimate that the largest trees (Redhaven/L IX/peach) should be planted at about 247 trees/ha (100/acre); those of intermediate size (Redhaven/K I/*P. americana*) should be planted at 880 trees/ha (350/acre); and the smallest (Redhaven/K I/Myrobalan B) would need 8900 trees/ha (3600/acre).

Fruit quality was not studied in detail, but a few general observations were made. Fruit from the *P. subcordata*/peach combinations tended to be late maturing and small sized, but of good quality. Trees on Marianna root tended to ripen their crops unevenly. They were usually of good

Table 4. Yield, tree growth and yield efficiency of peach on various interstem/ rootstock combinations

Cultivar	Interstem	Rootstock	Yield, first 3 yrs. kg	Yield, 8 yr. Total kg	Trunk area cross-section, 5 years cm ²	Yield efficiency per tree kg/cm ²
Redhaven	K I	Pach	20	114	86	13.2
Early Elberta	K I	Peach	30	109	89	12.3
Redhaven	L IV	Peach	55	159	113	14.0
Early Elberta	L IV	Peach	60	219	112	19.6
Redhaven	L IX	Peach	52	319	228	14.0
Early Elberta	L IX	Peach	66	259	135	19.2
Redhaven	K I	Marianna	11	43	45	9.6
Early Elberta	K I	Marianna	10	37	44	8.3
Redhaven	L IX	Marianna	4	5	24	2.1
Early Elberta	L IX	Marianna	13	70	38	18.4
Redhaven	Y. Kroos	Marianna	15	100	90	11.2
Early Elberta	Y. Kroos	Marianna	25	100	76	13.2
HaleHaven	Y. Kroos	Marianna	13	33	51	6.5
J. H. Hale	Y. Kroos	Marianna	20	55	65	8.5
Redhaven	K I	Myrobalan B	1	2	6	1.7
Early Elberta	K I	Myrobalan B	1	2	9	2.3
Early Elberta	L IV	Myrobalan B	2	4	21	1.9
Redhaven	K I	<i>P. americana</i>	19	72	61	11.8
Early Elberta	K I	<i>P. americana</i>	39	122	57	21.5
Early Elberta	L IV	Myrobalan B	2	4	21	1.9
Redhaven	K I	<i>P. americana</i>	19	72	61	11.8
Early Elberta	K I	<i>P. americana</i>	39	122	57	21.5
Redhaven	None	<i>P. tomentosa</i>	8	27	13	21.0
Golden Jubilee	None	<i>P. tomentosa</i>	2	24	20	12.2
Western Pride	None	<i>P. tomentosa</i>	4	16	12	12.9
Halberta Giant	None	St. Julien A	23	103	108	9.5

Table 5. Trunk size (cross-sectional area) of cultivar, interstem, and rootstock tissue for peach trees. (1972)

Interstem	Rootstock	Trunk size:			Ratio:	
		Scion	Interstem cm ² X-Section	Rootstock	Scion/ Interstem	Interstem/ Rootstock
K I	Peach	187	86	132	2.17	.65
L IV	Peach	216	245	230	.88	1.07
L IX	Peach	276	252	293	1.10	.86
K I	Marianna	117	45	64	2.60	.70
L IX	Marianna	113	177	133	.64	1.33
Yel. Kroos	Marianna	152	96	107	1.58	.90
K I	<i>P. americana</i>	148	84	84	1.76	1.00
None	Brompton	51	—	59	—	.86
None	St. Julien A	161	—	167	—	.96
None	<i>P. tomentosa</i>	50	—	50	—	1.00

Mineral nutrient content of peach leaves as related to understock combinations are shown in Table 6. Effects of interstems were relatively minor compared to those of the rootstocks which are summarized as follows:

High Levels	Low Levels
N — St. Julien A, peach	Marianna
P — St. Julien A	Marianna, <i>P. americana</i> , <i>P. tomentosa</i>
K — Brompton	Marianna
Ca — <i>P. americana</i>	Marianna
Mg — peach	Marianna
Mn — <i>P. tomentosa</i>	Marianna
Fe — peach, St. Julien A	Brompton, Marianna
Cu — St. Julien A, <i>P. tomentosa</i>	Marianna
B — peach	<i>P. americana</i> , Marianna
Zn — <i>P. tomentosa</i> , Brompton	<i>P. americana</i> , peach, Marianna
Al — peach, <i>P. americana</i>	<i>P. tomentosa</i>

Table 6. Mineral element content of peach leaves as related to interstem and rootstock (mean of all cultivars)

Interstem	Rootstock	Percent dry wt.					ppm dry wt.					
		N	P	K	Ca	Mg	Mn	Fe	Cu	B	Zn	Al
<i>P. subcordata</i> K I	Peach	3.82	.192	2.76	2.08	.604	50	180	7	36	17	122
<i>P. subcordata</i> L IV	Peach	4.30	.206	2.82	2.05	.642	48	194	8	40	16	116
<i>P. subcordata</i> L IX	Peach	4.19	.175	2.68	2.08	.600	35	208	8	34	18	139
Avg.	Peach	4.10	.191	2.75	2.07	.615	44	194	8	37	17	126
<i>P. subcordata</i> L IX	Marianna	3.11	.145	1.44	.71	.243	32	132	6	22	16	99
<i>P. subcordata</i> L IX	Marianna	2.98	.150	1.82	1.06	.270	38	172	7	30	24	130
Yellow Kroos	Marianna	3.15	.168	1.80	.88	.258	32	96	5	27	17	49
Avg.	Marianna	3.08	.154	1.68	.88	.257	34	133	6	26	19	93
<i>P. subcordata</i> K I	<i>P. americana</i>	3.58	.168	2.68	3.27	.482	46	163	9	23	15	126
None	Brompton	4.02	.200	3.05	2.08	.445	50	131	9	28	28	100
None	St. Julien A	4.15	.240	2.33	2.02	.510	75	191	11	34	25	86
None	<i>P. tomentosa</i>	3.97	.166	2.68	1.95	.445	1056	147	10	30	30	51
L.S.D. (.05 level)		.42	.022	.50	.33	.076	22	34	1.3	5	6	24

quality, except that the fruit of Halehaven/Yellow Kroos/Marianna had a high proportion of split pits. Trees on *P. tomentosa* matured their crop a bit early and the fruit was generally of good quality. Fruit quality was poor with Early Elberta/K I/Myrobalan B.

The relationship of tree size to rootstocks was apparent, but the size of the interstem and the ratios of scions, interstem, and rootstock sizes bore no consistent relationship to tree size (Table 5). As seen visually in Figure 1, the different combinations varied greatly in size, taper, and bulge at the union. All of the combinations shown appeared to be compatible, i.e. both phloem and xylem were continuous across all unions. The least compatible unions (not shown) were those of *P. subcordata*/Myrobalan B, most of which did not survive to the end of the test in 1972.

The effect of rootstock on mineral nutrient content of leaves has been widely discussed. In many cases the relative importance of rootstock to fertilizer practice has been questioned. But studies in California (3) have shown that peach/almond show less iron deficiency chlorosis than peach/peach. Peach/almond is less subject to alkali salts and to boron toxicity than is peach/peach. In soils low in available zinc, Marianna root resulted in less zinc deficiency than did peach root. These data along with those of Chaplin *et. al.* (2) on plum rootstocks indicate that the characteristic nutrient uptake of a rootstock should be considered in determining fertilizer practice.

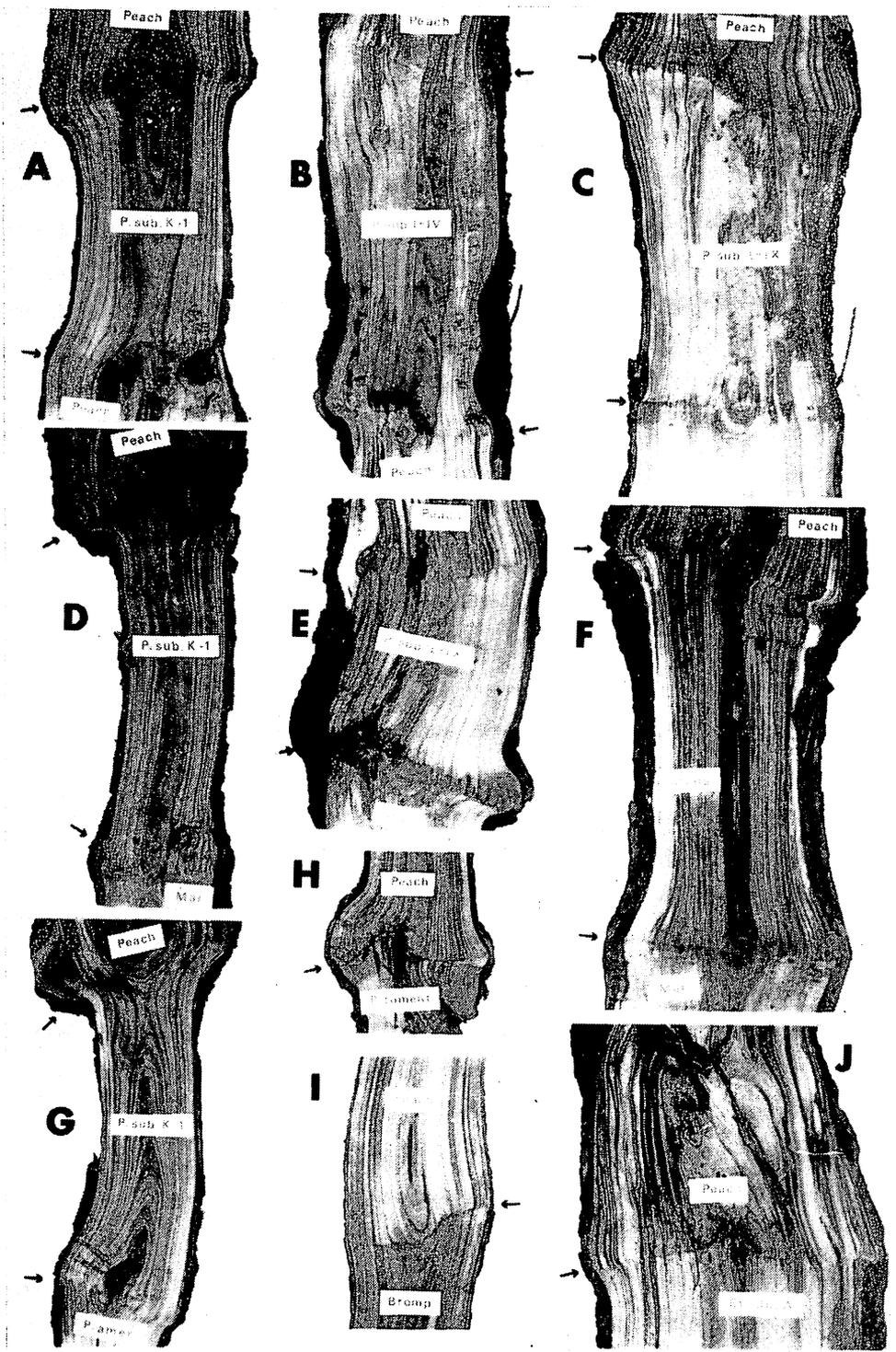
Table 7. Element-pair correlations in peach leaves for trees on peach and on plum rootstocks

Correlated element-pair	Rootstock:		Correlated element-pair	Rootstock:	
	Peach	Plum		Peach	Plum
	Significant "r" values			Significant "r" values	
N-K		.74	P-Mg		.37
N-P		.54	P-Cu		.41
N-Ca		.52	P-B	.55	.45
N-Mg		.65	Ca-Mg		.89
N-Mn		.65	Ca-Mg		.89
N-Fe		.60	Ca-Fe	-.51	.58
N-Cu		.80	Ca-Cu		.77
N-B		.40	Mg-Mn		.51
K-P		.52	Mg-Fe		.66
K-Ca		.84	Mg-Cu		.81
K-Mg		.89	Mn-Cu		.59
K-Mn		.57	Mn-Zn		.67
K-Fe	.64	.56	Fe-Cu		.63
K-Cu		.86	Fe-Al	.85	.63
K-B		.38	Cu-Zn	.60	
K-Zn	-.50		B-Zn		.51
K-Al	-.69				

For most elements there was more than 100 percent difference between the lowest and highest values recorded for different rootstocks. The highest N level was 44 percent higher than the lowest, and the high K value was 66 percent higher than the lowest. The most striking variations were with Ca (.88 to 3.27%) and Mn (32 to 1056 ppm). In general the leaf levels of most elements tended to be higher with peach and St. Julien A stocks than with the others, but this was not consistent for all 11 elements. By far the most consistent response was the



Figure 1. Median longitudinal sections of peach tree trunks showing graft unions (at arrows). Interstem/rootstock combinations (left to right) are as follows: A, K-I *P. subcordata*/peach; B, L-IV *P. subcordata*/peach; C, L-IX *P. subcordata*/peach; D, K-I/Marianna; E, L-IX/Marianna; F, Yellow Kroos/Marianna; G, K-I/*P. americana*; H, peach/*P. tomentosa*; I, peach/Brompton plum; J, peach/St. Julien A.



relatively low levels of all essential elements in trees on Marianna rootstock. This is the clearest evidence for partial incompatibility in the entire study and generally substantiates the results reported by Breen and Muraoke (1). However, in the present study the trees were not completely incompatible, having survived for 12 years or more.

Element-pair correlations were strikingly different between tree on peach and on plum rootstock (Table 7). Thirty significant correlations were different between the two types of rootstock and only three were similar. No clear conclusion can be drawn from these data as to their possible relationship to graft compatibility.

Literature Cited

1. Breen, P. J. and T. Muraoke. 1975. Seasonal nutrient levels and peach/plum graft incompatibility. *J. Amer. Soc. Hort. Sci.* 100(4):339-342.
2. Chaplin, M. H., M. N. Westwood, and A. N. Roberts. 1972. Effects of rootstock on leaf element content of Italian prune (*Prunus domestica* L.). *J. Amer. Soc. Hort. Sci.* 97:641-644.
3. Day, L. H. 1953. Rootstocks for stone fruits. Calif. Agr. Exp. Sta. Bul. 736, 76 pp
4. Gibson, Milo. 1964. Yellow Kroos plum as a rootstock for peach and plum. *Frt. Var. Jour.* 18(3):44.
5. Hedrick, U. P. 1911. The Plums of New York. NYAES Report, 616 pp.
6. Howard, W. L., and J. J. Heppner. 1928. Graft affinity test with peach on myrobalan and Mariana plum. *Proc. Am. Soc. Hort. Sci.* 25:178-180.
7. McClintock, J. A. 1948. A study of uncongeniality between peaches as scions and the Marianna plum as the stock. *J. Ag. Res.*: 77:253-260.
8. Roberts, A. N., and L. A. Hammers. 1951. The native Pacific plum in Oregon. Ore. Agr. Exp. Sta. Bull. 502, 22 pp.
9. Tukey, H. B. 1978. Dwarfed fruit trees. Cornell Univ. Press, 562 pp., illus.

Performance of Several Peach Cultivars on *Prunus tomentosa* and *Prunus besseyi* in Maryland

R. C. FUNT AND B. L. GOULART¹

Since the fruit industry has accepted semi-dwarf and dwarf apple orchards, researchers have considered high density peach orchards to be an essential goal for greater returns (1, 2, 3). Different peach rootstocks and double-worked trees have been investigated for tree size, control, stock/scion compatibility and suckering (4).

The use of *Prunus tomentosa* (Nanking Cherry) and *Prunus besseyi*, (Western Sand Cherry) as a rootstock for peach has not been commercially acceptable. However, there are few published data particularly as to cultivar compatibility. The objective of

this study was to investigate the compatibility of several peach cultivars grafted onto *P. tomentosa* and *P. besseyi* and to measure yield and potential use in intensive orchard plantings.

Materials & Methods

Rootstocks were purchased from a local nursery and planted in a nursery row at College Park, Maryland, in November 1974. The nursery was hand weeded and nitrogen was applied in the spring before and after budding. Trees were grown in well drained fertile soil. Bud sticks were taken from

¹Formerly Extension Pomologist, University of Maryland, and now Extension Horticulturist, The Ohio State University, Columbus, and formerly Horticulture technician, University of Maryland and presently, Graduate Research Assistant, The Pennsylvania State University.