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The Search for Peach Rootstocks Tolerant to Alkalinity

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Effect of Alkalinity on Peach Rootstocks

A large number of different types of rootstocks are being used for peach world-wide (15) and are principally derived from seedling sources. The sources are comprised of wild types, commercial cultivars and special rootstock selections. The first are usually obtained from peach trees that have escaped cultivation. The second are those used for commercial processing (15). Greater genetic uniformity is found in this group than those from the wild and therefore, their performance is more predictable (10). The third group consists of selections that have value only as rootstock seed sources for peach and nectarine. All the different stocks have special attributes which led to their introduction in the geographical regions where they originated. Some have wide areas of adaptation and are used in more than one country, or geographic region, while others appear to be more narrowly adapted. Other sources of rootstock include peach x almond hybrids and plum and plum hybrids.

In many peach producing regions of the world, pH is a major rootstock problem. Peaches grown on alkaline soil conditions with a pH ranging from 7.5 to 9.0 develop lime-induced Fe chlorosis due to low Fe availability, a condition that greatly reduces cropping efficiency. It is characterized by the interveinal chlorosis of younger leaves, which results from inhibition of chlorophyll synthesis. The rate of photosynthesis and subsequent growth of the plant is reduced as a result of this inhibition of chlorophyll synthesis (11). Chlorosis begins in the interveinal areas of the youngest leaves and the midrib remains green. In severe cases the whole leaf may be chlorotic and turn almost white in color. There is a reduction in terminal growth, leaves abscise and sometimes, twigs die back (3). Symptoms of Fe stress may be limited to a few branches or it may affect the entire tree. Young peach trees have been reported to die out completely (2, 3).

The Nature and Extent of Iron Deficiency Chlorosis

Although difficult to estimate, substantial losses do result from Fe chlorosis. The difficulty arises because of the irregular occurrence of the chlorosis, the case of marginal deficiency and the opportunity cost of growing less valuable crops, where certain high value but chlorosis susceptible crops cannot be grown. Cases of reduction in chlorosis, increased growth, and fruit yield have been reported from both the use of Fe compounds and tolerant rootstock materials to correct lime-induced Fe chlorosis. Syrgiannidis (18) observed less chlorosis, higher growth rate and fruit yield in trees growing on 'GF 677' rootstock in calcareous soil compared to chlorosis susceptible peach seedlings. The use of both FeEDDHA and HFe (Fe chelates) increased fruit size and yield of 12-year-old chlorotic 'Redhaven' peach trees growing on a clay loam soil in Colorado (14); while trunk injection of $FeSO_4$ into Fe defi-

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Table 1. Rootstocks tolerant to alkaline soil conditions.

Name	Origin	Propagation	Vigor	Root-knot Nematode	Water-logging	Compatibility	Other comments	References
				PEACH				
Montclar	France	Seed	1	*	S	*		12, 16, 17
Petit	Texas	Seed	1	*	*	*		
I-D-20	Greece	Seed	2	R	*	*		12, 16
			PEACH x ALMOND HYBRIDS					
'GF 677' (Amandier)	France	Clonal	1	*	S	Peach seedlings, Japanese & European plums	Drought resistant	10, 12, 16
'GF 577'	France	Clonal	1	R	MT			
'Hansen 536'	Calfor.	yClonal	1	I	S	Almond, peach & Japanese plum, but not with apricot		8, 10, 12
'Hansen 2168'	Calfor.	yClonal	1	I	S			
'Titan' Hybrids	Calfor.	Seed	1	R	S	Good with peach		10, 12
			PLUM & PLUM x PEACH HYBRIDS					
'Damas 1869'	France	Clonal	2	*	HT	Most peaches, European plums & almond, not nectarine	Good on wet soils, resistant bacterial canker	10, 12, 16
'Myrabi'	France	Clonal	2	*	MT	Certain peach cultivars		16
P. angustifolia Marsh	Texas	yClonal/ seed	3	*	T	*		
Brompton	England	Clonal	2	*	MT	Almond and European	Susceptible to bacterial canker Sharka disease. Some virus free clones available	10, 12, 16
'Prunier (GF 43)'	France	Clonal	1	*	T	European plums	No suckering. Collar, rootrot & Phytophthora resistant	10, 12, 16
St. Julien Hybrid #1	France	Seed	2	*	T	Peach & European plums	Some virus resistance	
St. Julien Hybrid #2	France	Seed	2	*	T		Collar rot resistant	10, 12, 16
St. Julien Hybrid A.	U.S.A.	Seed	1	*	T	European plums, not with 'Stanley'	Resistant to low winter temperature. Good Ca absorption. Some virus free	12

1 = High, 2 = Moderate, 3 = Poor, * = Unknown or unpublished.
y = Tolerance to alkalinity not yet confirmed.
I = Immuned, R = Resistant, S = Susceptible, T = Tolerance, HT = High tolerance, MT = Moderately tolerant.

cient plum trees in California, resulted in a distinctly higher average fruit set (339 per tree) compared to 44 per tree in control treatments (22). Similarly, trunk injection of Fe compounds into severely chlorotic 'Red Delicious' apple (*Malus domestica* Borkh) trees on a calcareous soil in Utah significantly increased bloom and fruit yield, compared to chlorotic controls with no flower clusters (1). The trunk injection was effective in promoting bloom for two years.

Thorne and Petterson (20) estimated that 55 percent of the world's land area lies in regions receiving less than 50 cm of rain per year, and approximately 20 to 30 percent of this is calcareous in the surface horizon and therefore problematic for Fe chlorosis in susceptible crops (21). Alkaline and calcareous soils include many of the most fertile soils of the world (13). A survey of the arid regions in Utah showed that 23 percent of the orchards in the state were affected by Fe chlorosis (19). The calcareous soil belt with low available Fe stretches through a very broad area in the center of the United States and covers much of the Great Plains region. It starts in Nebraska, passing down through the boundaries of Kansas and Colorado, and western Oklahoma, eastern New Mexico and down to northwestern Texas; reappearing again south of San Antonio, Texas (4, 21). Information about the performance of commercial fruit trees under alkaline soil conditions is very limited, but several reports indicate that there are tolerant species.

Rootstocks Tolerant to Alkaline Soil Conditions

In addition to alkalinity tolerance, other desirable characteristics are required of rootstocks for peach cultivars. Tolerance to drought, heat and disease, root-knot-nematode and insect resistance, cold hardiness, compatibility with a broad range of scion cultivars and ease of propagation by seed and asexual methods that provide early growth in the nursery. Freedom from viruses, control of scion vigor, adaptation to a wide range of soil types, low suckering and good anchorage are important traits. Although no single rootstock may possess all the traits, the incorporation of as many of these as possible into selected rootstocks is of interest in rootstock improvement programs.

Peach Rootstocks

In North America, the most widely used rootstocks are Nemaguard, Nemared, Lovell and Halford. All these show Fe chlorosis under alkaline conditions. Rootstock materials such as Okinawa, FLA 14-11 and FLA 9-4 which have been selected under acid soil conditions for nematode resistance show extreme susceptibility to Fe chlorosis under alkaline conditions and grow so weakly that they may die within a few years from planting. Some peach rootstocks, however, show tolerance to alkaline soil conditions—Table 1. Montclar is a seed propagated rootstock selected in France (17), while Petit is a low chill seed propagated selection from the Rio Grande Valley area of Texas and I-D-20 is a selection from Greece. All these are moderately vigorous to vigorous rootstocks. Montclar is susceptible to waterlogging (17) while I-D-20 is resistant to root-knot-nematode (10, 12) but little else is known.

Peach x Almond Hybrid Rootstocks

Peach x almond hybrids have been repeatedly reported tolerant to alkaline soil conditions (6, 7, 18). These hybrids which include four clonal rootstocks ('GF 677,' 'GF 577,' 'Hansen 536,' and 'Hansen 2168') and two seed propagated rootstocks ['Titan x Nemaguard' (TNG), 'Titan x Nemared' (TNR)] are very vigorous and generally sucker less than many peach rootstocks (6). Most of these show some resistance to root-knot-nematode.

'Hansen 536' and 'Hansen 2168' (8, 10) were developed for root-knot-nematode resistance, but their tolerance to alkaline soil conditions have not yet been confirmed. Although 'GF 677' is not resistant to root-knot-nematode, it is sufficiently vigorous to withstand the attack by *M. incognita* but not *M. javanica* (5). Peach x almond hybrids are generally graft compatible with peach and plum but not apricot. Although the clonal rootstocks are very uniform in the field, they are difficult to propagate by cuttings. However, *in vitro* micropropagation technique has proven commercially successful in Europe (10). Seed propagated rootstocks produce more variable seedlings requiring rogueing of off-type seedlings in the nursery row before budding. Reports indicate that 'GF 577' is moderately tolerant to waterlogging while 'GF 677' is tolerant to drought (10). 'GF 677' has shown satisfactory levels of cold hardiness in tests.

Plum and Plum Hybrids

Plums and plum hybrids are also used as rootstocks for peach (10, 15). This group which includes rootstocks derived from *P. insititia* (St. Julien hybrids # 1 and 2), *P. domestica* ('GF 43') and *P. domestica x P. spinosa* ('Damas GF 1869') have better adaptation to wet waterlogged soils than other *Prunus* spp. (9, 10) in addition to their tolerance to alkaline soil conditions. However, 'Damas GF 1869' is incompatible with many nectarine cultivars and suckers excessively which limits its use as a rootstock. In North America, plum rootstocks are seldom used for peach due to incompatibility of peach on plum rootstocks (5, 10). 'Myrabi,' Brompton, 'GF 43,' St Julien hybrids #1 and 2 and St. Julien hybrid A are plum and plum hybrid rootstock selections of commercial importance. In general, they exhibit moderate vigor, except for the more vigorous 'GF 43' and St. Julien hybrid A. Most have good compatibility to peach, almond and European plums, while St. Julien hybrid A is resistant to cold temperature. North American materials that have shown some tolerance to alkaline soil conditions include selections of *P. angustifolia* (Chickasaw plum in Texas) and Clark Hill Redleaf (*P. cerasifera*) from Georgia. Little is known about these rootstocks currently and more testing is required to confirm their tolerance to alkalinity as well as other desirable traits. In general little is known about the tolerance of the rootstocks used for peach to alkaline conditions and other desirable attributes. However, with increased interest in researching this problem in North America and elsewhere and the systematic testing of rootstock materials the adaptation of these various rootstocks to different soil conditions will become known. There is good potential for further improvement of the tolerant rootstocks known through breeding and selection.

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The Changing Strawberry Cultivar Situation in North America

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Introductory Remarks

Ten years ago, at the American Society for Horticultural Science meeting in Boston, the American Pomological Society sponsored the first of a series of workshops on the current cultivar situations with respect to the major fruit crops grown in North America. These workshops, which took place over a period of several years, were successful with each one ultimately being published in Fruit Varieties Journal. It was decided it would be appropriate for APS to revive the cultivar workshop series and that the logical crop with which to do this would be strawberry. This crop started the series and is the one which has undergone the most changes with respect to cultivars. Moreover, it is anticipated that there will be more changes in the next decade. The reasons for the changes and anticipated changes include (1) the increasing unavailability of chemicals for pest control and thus the increasing need for greater levels of pest resistance; (2) the desire for improved fruit qualities; (3) the increasing use of day-neutral cultivars; (4) the increasing use of annual planting systems; (5) the high cost of hand harvest and the potential of machine harvest for processing berries; (6) the increasing influence of the private sector in sponsoring breeding programs and (7) the expansion of production regions. With reference to the last, it is worth noting that we are now considering six general regions, rather than the four considered in 1978.

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