Rootstocks for Cherry, Plum, and Apricot — Present and Future

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Cherries, plums and apricots are not as widely grown as the fruits already discussed in this series. Because their fruit is very desirable, several generations of fruit breeders have worked to adapt these crops to wider areas of of the world. Their efforts have yet to be succesful; commercial production is still limited to a relatively few climatically favorable areas. As a result these fruits demand a higher price per pound than other tree fruits.

Cherry, plum, and apricot, along with peach, make the *Prunus* genus one of the most important for fruit crops. Rehder (39) divides the approximately 200 temperate zone species into five sub-genera (Table 1). Prunophora is separated from Amygdalus on the basis of the former's solitary axillary buds and lack of terminal buds. Species in both of these subgenera have fruit with a suture (sulcate) whereas the fruit of cherry species lack sutures. Generally the cherries in Cerasus are borne on stalks in small groups while cherries in Padus are borne on multifruited racemes. Laurocerasus is distinct among temperate species in having evergreen leaves. Crosses between sub-genera are rarely successful with the exception that the sand cherries have been a bridge between plum, peach and cherry and, in fact, may be more closely related to plums than to cherries.

Table 1. *Prunus* subgenera as classified by Rehder (39).

Subgenus	
Prunophora	Old World Plums New World Plums Apricots
Amygdalus	Peaches Nectarines Almonds
Cerasus	Sand Cherries* Flowering Cherries Sweet Cherries Sour Cherries
Padus	Bird Cherries Black Cherries Choke Cherries
Laurocerasus	Cherry Laurels

*Considered plums by some.

CHERRIES

Cherry species of economic importance (Table 2) fall in the Cerasus subgenus. In the U.S., cherries are more valuable as a crop than plum or apricot (53). Sweet cherry production is concentrated in the Pacific coast states and Michigan, with smaller areas of production in Utah, New York, Idaho and Montana. Tart or sour cherry production is concentrated in Michigan with minor production in New York, Wisconsin, Utah, Pennsylvania, Oregon and Colorado. West Germany and the U.S. lead the world in production of cherries, followed by Turkey, Italy, France, Yugoslavia and Spain.

The primary rootstocks for cherry are Mazzard and Mahaleb (Table 2). Mazzard rootstocks have been used for over 2000 years in Europe, but only since the 18th century in this country (18). Mazzard rootstocks traditionally have come from seed of wild trees in Europe, but U.S. seed now come from trees of certified Mazzard strains or from commercial sweet cherry orchards (primarily Bing x Van). Although it germinates errat-

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ically, and can be budded for only a short time, Mazzard is currently the rootstock of choice for sweet cherries in the eastern U.S., especially on heavy soils (57), and also for sour cherries on heavy soils or where *Phytophthora* is a problem. Although producing large, long-lived trees tolerant to *Phytophthora* root rots (29), Mazzard rootstocks transmit buckskin disease and are susceptible to crown gall (34, 46). F12/1, a clone from East Malling Research Station in England, has good *Pseudomonas* canker resistance and so is used in the Pacific Northwest as a high-budded stock (2, 41). Its use in the East is limited by susceptibility to crown gall, excessive vigor and lesser cold hardiness of the scion compared to those on Mazzard seedling stocks (28, 46).

Controversy still exists concerning the use of Mazzard versus Mahaleb (6, 57). Mahaleb came into use in the 18th century in Europe and about 100 years later in the U.S. By 1920 it was very popular probably because the seedlings were easier to grow and bud in the nursery (18). Mahaleb rootstocks are generally preferred on lighter soils particularly for sour cherries. They are sometimes used for sweet cherries in the West. Mahaleb seedlings have shown some incompatibility with eastern sweet cherry cultivars. On heavier soils, scions may be somewhat dwarfed, with earlier bearing. This rootstock is very hardy, does not transmit buckskin disease, is less susceptible than Mazzard to canker (2), but is more susceptible to *Phytophthora* (30). Numerous clones of Mahaleb are available, including INRA St. Lucie 64, a French stock tolerant to drought and calcareous soils. OCR-2 and other apparent hybrids of Mahaleb x Mazzard (MxM) selected in Oregon are characterized by cold hardiness, canker resistance, lack of suckering, and in some cases, dwarfing of the scion and precocious bearing (46, 47, 58).

P. cerasus is the only other cherry species widely used as a rootstock.

Table 2. Important cherry species (*primary rootstocks).

Species	Common name	Origin	Use
P. avium L.	Sweet cherry	Europe	fruit
	*Mazzard cherry (wild)	Europe	rootstock
P. besseyi Bailey	**Sand cherry	U.S.	hardy fruit, dwarfing stock
P. cerasus L.	Sour cherry Tart cherry	Europe Asia Minor	fruit, rootstock
P. fruticosa Pall.	Ground cherry Siberian cherry	Europe, Siberia	dwarfing stock
P. mahaleb L.	*Mahaleb cherry St. Lucie cherry	Europe	rootstock
P. tomentosa Thunb.	**Nanking cherry	China	hardy fruit, dwarfing stock

**Tend to be more compatible with plums than cherries.

Stockton Morello is a clone originally used near Stockton, CA to adapt sweet cherries to wet, heavy soils (6). It is very sensitive to stem pitting virus but immune to rootknot nematode. Its ability to induce dwarfing and precocious bearing was apparently due to the presence of viruses since virus-free clones have produced standard-size trees. In Italy clones CAB6P and CAB11E have been selected from local sour cherry populations (12). A clone of the Vladimir group of sour cherries, selected in California but of Russian origin, induces severe dwarfing and early spur formation, but requires support and causes some overgrowth and suckering (29, 42).

Clones of *P. fruticosa* appear promising for the future. At Geneva, NY selections FR-1, -3, -4, -5, -6, and -8 have been found to be winter hardy, early-bearing, dwarfing and resistant to leaf spot (7). Oppenheim from Europe apparently has similar qualities but may sucker when young and is incompatible with Bing (19, 38).

Many other species and hybrids are under test as candidate rootstocks for cherries. Cummins' comprehensive review (8, 9) lists 35 species tested or under test, the most promising being *P. dawcykensis*, *P. incisa*, *P. nipponica*, *P. kurilensis*, *P. serrulata*, *P. subhirtella*, *P. yedoensis*, *P. canescens*, *P. mollis*, *P. mugus*, and *P. pseudocerasus*. One hybrid (*P. avium* x *P. pseudocerasus*) named Colt by East Malling offers ease of propagation by cuttings, *Pseudomonas* canker resistance, *Phytophthora* tolerance, and precocious cropping (30, 54), but apparently is drought susceptible (46, 59). Initial reports of size control have not been borne out everywhere (36). VP-1 (*P. cerasus* x *P. maackii*) from the Soviet Union is reportedly very winter hardy, easy to propagate, and compatible with sweet and sour cherries (25). Hybrids made at Giessen, West Germany have involved at least 10 species, of which *P. fruticosa*, *P. canescens*, and *P. cerasus* provided dwarfing and precocity (16). Trefois and associates in Belgium have tested a wide spectrum of the ornamental cherries as rootstocks (49). Singh and Gupta suggest several native Indian species for use with cherry (43). Other reviews of cherry rootstocks are available (5, 26, 50, 52).

PLUMS

Plums and prunes (plums with enough sugar content to be dried without removing the pit) are grown primarily in California although the Pacific Northwest and Michigan produce some prunes (53). There are also small local plantings throughout the country. U.S. prune production, marketed fresh, canned and dried, is about quadruple that of plums. Yugoslavia and West Germany lead European production.

Commercial plums encompass more species and a wider range of germplasm (Table 3) than most other fruit crops. *P. domestica*, cultivated for nearly 2000 years, is the most important species, providing many fresh fruit cultivars as well as all the prune cultivars (17). Damson plums (*P. insititia*), which are similar, are grown primarily in Europe. These two species are hexaploid and thus are genetically isolated from most of the other species which are diploid. The native American species have produced many adapted cultivars that are grown locally in various parts of the country. Most of the important shipping plums of California contain genes of one or more of these native U.S. species in combination with the Japanese plum (*P. salicina*), which predominates. Six little-known species with pubescent fruit are also native to the southwest U.S.: *P. andersonii*, *P. fasiculata*, *P. fremontii* ,*P. havardii*, *P. minutiflora* and *P. texana*. Their taxonomic position is unclear. Very little research has been done with them since they were reviewed in 1913 (31). They may have useful germplasm for rootstock breeding so collections of them have been assembled at Byron and Fresno, CA.

Plum rootstocks in Europe naturally were derived from the available species. Ackerman, Brompton *(P. domestica)*; Damas, Mussel, St. Julien *(P. insititia)*; and myrobolan *(P. cerasifera)* have been used for centuries there (11, 17, 24, 48, 50, 51), but only myrobolan has found wide application in the U.S. Several European clones are being tested in the U.S. INRA GF 43 *(P. domestica)* produces dwarf, productive trees resistant to *Phytophthora* rots and wet soil (23). Pixy and St. Julien A are *P. insititia* selections from East Malling. St. Julien A appears tolerant of low temperatures and is slightly dwarfing but suckers badly. It is apparently more susceptible to bacterial canker than other plums (15). Pixy is compatible with European plum cultivars (but not peaches), does not sucker, shows some *Pseudomonas* canker resistance and induces precocious bearing (54, 55). Preliminary results with five Japanese plums in California indicate Pixy is compatible with them. It is the most dwarfing stock available, but appears to be drought susceptible and has not been widely tested in the U.S. (46). Tests in Oregon of other European clones indicate Damas C and Common Mussel deserve further study (4, 56).

Table 3. Important plum species (*primary rootstocks).

Species	Common name	Origin	Use
P. americana Marsh.	hog plum, American plum	eastern U.S.	fruit, stock
P. angustifolia Marsh	Chickasaw plum	southeastern U.S.	fruit
P. cerasifera Ehrh.	cherry plum *myrobolan plum	Europe, Asia	fruit, stock
P. domestica L.	*European plum prune	Asia	fruit, drying, stock
P. hortulana Bailey	hortulan plum wild goose plum	central U.S.	fruit
P. insititia L. (Bullace)	*Damson plum Bullace plum	Europe, Asia	fruit, stock
P. maritima Marsh	beach plum	northeast U.S.	fruit, stock
P. munsoniana Wight & Hedr.	wild goose plum	central U.S.	fruit
P. salicina Lindl.	Japanese plum	China	fruit
P. simonii Carr.	apricot plum	China	fruit
P. subcordata Benth	Pacific plum Sierra plum	northwest U.S.	fruit, stock

Myrobolan is used both as a seedling and as a clonally propagated stock. In Michigan myrobolan seedlings are used for Stanley plum because they tolerate cold weather and heavy soils better than peach. Myrobolan 29C, a clone selected in California for immunity to root-knot nematode, produces a large, long-lived tree that may produce many suckers and is susceptible to oak root rot (10). Widely used, it is available commercially in California and Oregon. Clone M20-3 from Michigan State propagates well, tolerates clay loam soils, and is compatible with Stanley and Blufre (3). Myrobolan B from East Malling is also being tested in the U.S.

Marianna (apparently *P. cerasifera* x *P. munsoniana*) has been quite popular since its origin in Texas in the 1890's. Clones selected from Marianna propagate easily by cuttings, induce early bearing, are widely compatible, and are adapted to many soils (57). Anchorage may be weak in young trees. Marianna 2624 from California is immune to root-knot, moderately resistant to oak root rot and crown rot, but very susceptible to bacterial canker (10). It is widely used on the West Coast. Marianna 4001, also selected in California for root-knot immunity, produces a very vigorous tree that is drought tolerant and can outgrow *Pseudomonas* canker infection (56). INRA GF8-1 is a selection used in Europe for its tolerance to wet calcareous soils and its vigor (23). In South Africa, Santa Rosa on Marianna clone 7/2 has outyielded trees on Mariana and peach seedling stocks (20, 44). Other South African selections appear to induce dwarfing as well (21).

The third main rootstock for plums in the U.S., and the most popular, is peach. Most plums are compatible on peach, and such trees are less prone to *Pseudomonas* canker and suckering than those on plum stocks (2, 35, 56). Peach is best adapted to lighter, better drained soils. Halford, Lovell and Nemaguard are the peach stocks most commonly used since they are readily available. The choice between them depends on the site rather than the scion since Nemaguard is resistant to several root-knot nematode species. Peach rootstocks are the subject of a separate presentation so they will not be covered further here.

Other *Prunus* species are occasionally used as rootstocks for plum. Apricot *(P. armeniaca)* and almond *(P. amygdalus)* are only recommended for soils high in boron or calcium (35). Peach x almond hybrids — GF 557 and GF 677 — are sometimes used in Europe on high calcium soils (23). Another French stock, GF 31 (myrobolan x *P. salicina*), is recommended for wet soils (23). *P. triloba* and *P. spinosa* showed poor bud-take and poor growth as rootstocks in The Netherlands (36). *P. subcordata* has been suggested as a possible stock for its apparent resistance to oak root rot (10) although it produces suckers readily and exhibits poor transplant survival (40). As a scion some clones of this species were compatible with stocks of myrobolan, Marianna, *P. americana* and peach (40). *P. maritima* has been found a promising dwarfing stock for Japanese plums in New Zealand (13). Buck plum (apparently *P. cerasifera* x peach), extensively used only in New Zealand, produces very vigorous trees and is widely compatible (13). *P. tomentosa*, *P. besseyi* and *P. cistena* (purple-leaf sand cherry = *P. pumila* x *P. cerasifera*) have been used to dwarf plum, but have not been commercially satisfactory (36, 46). *P. tometosa* increases scion susceptibility to *Pseudomonas* (2) and shows poor bud-take. Anchorage and compatibility are problems with *P. besseyi*. *P. americana* is sometimes used in the U.S. to impart greater winter hardiness to the scion (46) and is available from at least one nursery. Other native American species have occasionally been used as rootstocks in specific areas.

APRICOTS

Apricots, the least widely adapted of the three fruits, are grown primarily in California. World production is centered in southern Europe (53). Most fruit cultivars belong to *P. armeniaca* (Table 4).

Relatively little has been done in developing stocks specifically for apricot. Apricot seedlings, which make compatible, vigorous rootstocks, are widely used (33, 45). Most are immune to root-knot and resistant to *Pratylenchus* spp., root-lesion nematode. In France a wild apricot selection, INRA Manicot, provides very uniform and vigorous seedlings (23). Related cold-hardy species *P. mandshurica* and *P. siberica* are suggested as rootstocks for colder areas (22, 50).

Peach is also commonly used as a rootstock for apricot (57) although compatibility problems do arise (27). Lovell, Halford, and Nemaguard are used most often. Peach rootstocks appear better adapted to light, dry soils. On heavier soils plum rootstocks can be used. In California myrobolan 29C and Marianna 2624 are suggested (33), while Brompton and INRA clones GF31, GF8-1 and GF1380 are recommended in France (23, 32). Again there are some incompatibilities (1). In South Africa, Marianna clone 7/7 has given a greater yield efficiency than apricot seedling stocks for Peeka apricot (45).

Other species are used for apricot in special situations (37). *P. besseyi* has been used for backyard dwarf trees (33). Apricot is apparently incompatible with *P. tomentosa* (14).

FUTURE POSSIBILITIES

For these three crops, increased international cooperation is needed to speed up rootstock development. New rootstocks need to be widely tested because conditions vary so from one growing area to another. The future of cherry rootstocks looks most promising. New clones have the potential to meet specific local needs for size-control and disease resistance. Future stocks will likely be clonally propagated to insure uniformity and integrity of characteristics. Multi-state testing of new cherry rootstocks has been initiated by the NC-140 Regional Rootstock Committee with the European hybrids to be included by 1985. New emphasis on cherry rootstocks in Michigan has resulted in initiation

Table 4. Important apricot species.

Species	Common name	Origin	Use
P. armeniaca L.	apricot	Asia	fruit, stock
P. brigantina Vill.	Briancon apricot	France	seed for oil
P. dasycarpa Ehrh.	purple apricot	?	ornamental
P. mandshurica (Maxim.) Koehne.	Manchurian apricot	China, Korea	hardiness
P. mume (Sieb.) Sieb. & Zucc.	Japanese apricot	Japan, China	ornamental, pickling
P. siberica L.	Siberian apricot	Siberia, China	hardiness

of a full scale breeding program there. For plums most of the rootstock development is taking place in England and France. In the U.S., progress on rootstocks for plum depends on improvement of peach rootstocks and testing of plum rootstock clones from Europe. Apricot stocks receive even less attention in both the U.S. and Europe, probably because they are grown in such limited areas. Apricots will, however, benefit from compatible peach and plum rootstock development, probably with little or no scientific testing. For both plums and apricots there is a great need for breeding work done in this country.

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Book Review

The Pear — Cultivars to Marketing. Horticultural Publications, 3906 N.W. 31 Pl., Gainesville, FL 32606. Illustrated. Edited by Tom van der Zwet and Norman F. Childers with 68 pear specialists around the world. All leading pear countries are represented. 502 pages. Foreign $30; domestic $25. Checks accepted on U.S. banks. 1982.

This book honors two men who were distinctive in pear research and teaching: Ulysses P. Hedrick, former Director of the New York Agricultural Experiment Station, Geneva and Dr. John Robert Magness, formerly of the Agricultural Research Center, U. S. Department of Agriculture, Beltsville, MD. Other pear researchers recognized were: Dr. Thomas J. Burrill, who discovered the cause of fireblight at the University of Illinois; Dr. Merton B. Waite, USDA breeder of pears; and Dr. Frank C. Reiner, grower-breeder of fireblight resistant pears in Oregon.

The book is divided into 9 sections as follows: 1) Cultural practices, 2) Flowering, fruit set and varieties, 3) Breeding programs, 4) Rootstocks and propagation, 5) Nutrition and leaf analysis, 6) Growth regulators, frost costs and pruning, 7) Diseases, pests and weeds, 8) Fruit maturity, harvesting, storage and marketing, and 9) Pear products, their nutritional values and consumption trends.

This book is an invaluable resource for those involved in teaching research, extension and the growing of pears. It is an update compilation of information concerning pears not to be found elsewhere under one cover.

—R. K. Simons