Fruit Tree Rootstocks for Michigan 2012

Dr. Ron Perry
Department of Horticulture
Michigan State University

Terms:

- Rootstock -root system of grafted (budded) tree Scion - top of grafted (budded) tree Stion -stock/scion combination

- Interstem (Interstock) -section of trunk between stock and fruiting scion

WHY USE ROOTSTOCK?

- A. Propagate the fruiting scion onto a root system
- B. Gain uniformity in fruiting portion (compared to seedlings)
- C. Control tree size (vigor)
- D. Adapt to adverse soil conditions (pH, texture, drainage, drought, etc.)
- E. Tolerate soil pests (insects, diseases, nemas)
- F. Increase hardiness to low temperature

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Incompatibility

- Definition: Failure of tree as a result of scion/rootstock interaction. -can be translocated or not translocated -often virus induced Examples:
- -Cherry: Hedelfingen/Mahaleb - Napoleon/Mahaleb OK
- -Virus induced: Bing/Stockton Morello

  Stanley plum/Myro OK union constriction TmRSV

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Rootstocks for Tree Fruit Crops

- Apple growers have had an arsenal of **clonal** rootstocks to select from which were developed through breeding in England.
- All other crops have tried to mimic the history and success in developing apple rootstocks.
- Many stocks are still today propagated on **seedling** rootstocks; peach, apricot, many plums, and many cherry

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Development of new rootstocks depends on breeding and subsequent long term field testing

1. Breeding began for many crops in Europe.
2. Researchers have been bringing many of these rootstocks to America to test in field plots and determine performance and adaptation.
3. Concurrently, some institutions and private breeders began the task of making crosses and developing new genetic material for adaptation to American soils and climate
4. Testing is long term and usually conducted in phases.

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5. Following years of field testing; local or regional advisors make recommendations.
6. A multi-state regional project supported by State and Federal funding began in 1975 called NC 140 (NC = North Central). Researchers in mid-western Lang Grant Institutions began developing uniform trials for testing in states/regions. Today this project includes national, Canadian and Mexican cooperators.
7. Supported by Commercial Tree Fruit Nurseries and the International (Dwarf) Fruit Tree Association (initiated by Dr. Bob Carlson, Prof MSU).
8. See http://www.nc140.org/

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Apple

Historically, apple growers depended on propagated scion varieties on seedling rootstocks.

- US – prior to 1930 French Crabapple
- Today in the US, a small number of trees are propagated on seedlings derived from seeds from processed apples such as Red Delicious from WA
- Seedlings still have their application, especially on the West Coast where trees are 50% smaller than same grown in Midwest and Eastern US
- Others used are the Antonovka (hardy; from Russia) Northern spy (wooly apple aphid resistant, used still today in NZ and AUS where the problem still exists).

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Apple

Since the mid 1950s (following the start of the IDFTA) **Clonal** rootstocks – have become more popular mainly due to series found that dwarf scion varieties

- 1600-1700's -French gardens "Paradise" 1913 -East Mailing series
- 1920's EM I-XXVll MM series -John Innes Institute, Merton, England: EM's x Northern Spy (greater range of size control and wooly apple aphid resistance)
  - 15 stocks introduced: MM 101-115 1970's -Long Ashton EMLA series EMLA 27 and others Virus free Other clonal stocks
- Alnarp 2 (Swedish, hardy)
- Robust #5 (M. baccata x Prunifolia; Canada; field hardy
- Budagovski series} Polish series}
- MSU; Dr. Carlson Experimental MAC series (grew out open pollinated seedlings = yielded MARK rootstock
- Late 1960's Cornell-Geneva series, New York (USDA)
  - http://www.ars.usda.gov/

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Development of new apple rootstocks depends on breeding and subsequent long term field testing

Searching for an improved new rootstock

- a. Must root and sucker readily in stool bed
- b. Influence great range in vigor
- c. Yields influenced precocity + smaller trees density = light competition branch angles fruit/shoot ratio
- d. Support required for M.9, Mark, M.26, etc.
- e. Suckering may be accelerated M.7 planted deep to increase anchorage and decrease suckering (union above soil)
- f. Shallow rooted high density root system requires supplemental irrigation
  - M.9 = poor water conductivity through roots
- g. Increased precocity - scion central leader must be de- fruited or supported

B. Nursery Terms:

- EMLA East Malling-Long Ashton completely virus free (free of all except 2 latent viruses)
- No change in horticultural characteristics except vigor

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Apple

Precautions and characteristics of clonal stocks

- **Must root and sucker readily in stool bed**
- **Influence great range in vigor**
- **Yields influenced precocity + smaller trees density = light competition branch angles fruit/shoot ratio**
- **Suckering may be accelerated M.7 planted deep to increase anchorage and decrease suckering (union above soil)**
- **Shallow rooted high density root system requires supplemental irrigation**
- **Support required for M.9, Mark, M.26, etc.**
  - **Because of precocious nature of influence of rootstock**
  - **Brittle roots; function of ratio of xylem to phloem tissue**


M.9


M.7

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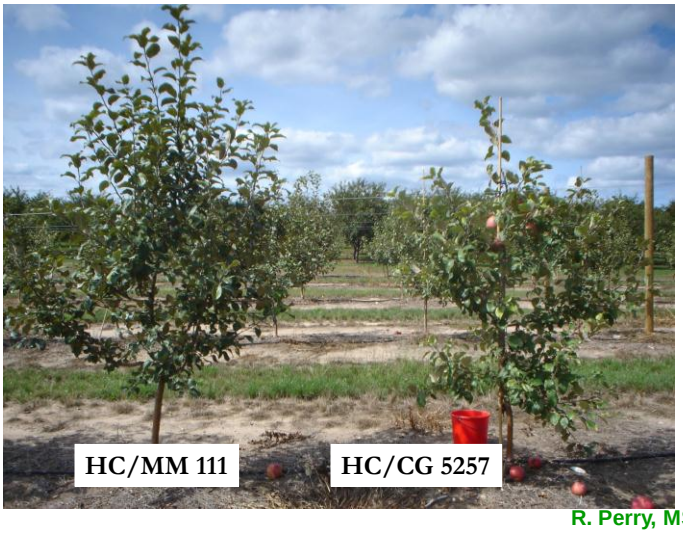
Cropping, especially on precocious rootstocks, eliminates dominance of Central Leader

Rootstocks can dwarf and improve precocity; Honecrisp rootstock trial TC



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- **M.9 = poor water conductivity through roots**
- **Increased precocity -scion central leader must be de-fruited or supported**
- **Burr Knots more prevalent – adventitious rooting initials**
  - **Root initials extend when exposed to soil**

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Scion Rooting in Apples

- Problem: If scion tissue (trunk) is exposed to soil, apples may produce adventitious roots.
- Scenario: trees planted deeper than recommended; where unions are at / below soil line.
- Consequences:
  - Year 3 trunk tissue exposed to soil generate roots (usually from Burr Knots on clonal rootstocks.
  - Year 7 roots generated from trunks become and influence vigor (increase) of tree.
  - Year 7 + roots and dwarfing influence by dwarfing rootstocks is compromised.

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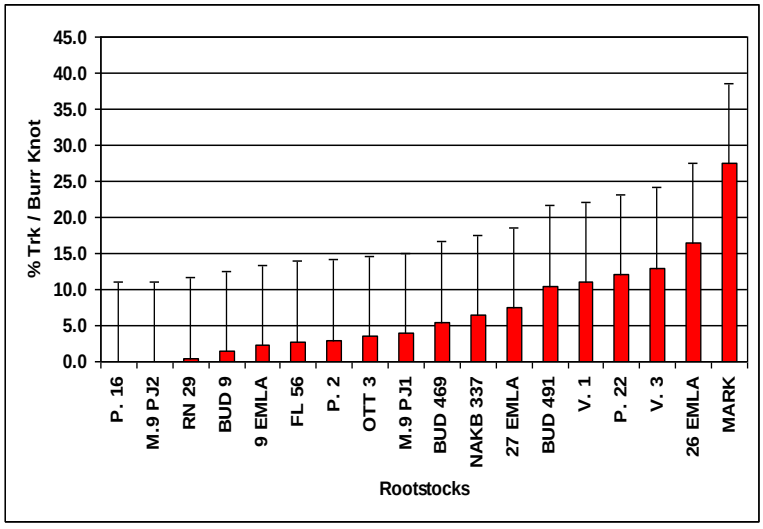
% Trunk Area (RS shank) covered by Burrknots



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Impact of scion rooting in apples

Golden Del / M.26

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Commercial Vigorous and Semi Vig

M.7a

- + adapts to wide range of soils + tolerates fireblight
- -lacks precocity - -suckers badly
- -some leaning -non-radial root system -Susceptible to Phytophthora -Not precocious

MM.III

- + drought tolerant
- + adapts to wide range of soils + deep root system
- -large and vigorous
- -susceptible to Phytophthora

MM.I06

- + semi standard
- + good precocity and yields -sensitive to:
- -heavy soils
- -poorly drained soils
- -Phytophthora (collar or crown rots) -union necrosis ?

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Commercial Dwarf Stocks

M.26

- **Pros:**
- Small tree
- Good fruit size and quality
- Good production once established Cold hardy
- Good vigor for Vertical Axe
-
- **Cons:**
- Incompatible with triploids and Northern Spy Needs will drained, deep fertile soils
- Highly susceptible to Phytophthora and fire blight
- Burr Knots
- Needs to be supported

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Commercial Dwarf Stocks; Lower Vigor M.9's

Budagovsky 9 (B.9 or Bud.9)

- M.8 x Krasnij Standart
- Similar vigor to weakest M.9 clones, ie, FL.56
- Consistent cropping across varieties and years No License Protection (not patented) Developed in Russia
- Excellent cold hardiness Resistant to Crown Rot
- Performs well in wide range of soil types
- Similar productivity and precocity to M.9 clones.
- Appears to confer FB tolerance to canopy (Field observations). Lab tests indicate that the tissue itself is susceptible to FB, but less than M.9.

M.9 NAKB 337

- Virus Free clone from Holland
- Currently dominates the M.9 strains available in U .S. (80%) Thus far in Michigan, inferior in performance to other M.9 clones.
- Appears to be 5-10% less vigorous than M.9 EMLA
- Only caution: We have noticed that it transplants slowly, especially if poorly treated in shipment/storage.
- Susceptible winter injury , as all M.9 clones.

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Apple rootstock trials; Michigan

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Commercial Dwarf Stocks; Upper Vigor M.9's

M.9 EMLA

- Virus free clone from East Malling / Long Ashton
- Has been under evaluation in N .A. for at least 20 yrs. 5-10 % more vigorous than NAKB 337
- Canopies of scions are vigorous and alternate bear problem for Jonagold and other varieties that are prone.
- Highly tolerant to Phytophthora root rot Highly susceptible to fireblight Small tree
- Moderately cold sensitive Burr Knots
- For high density plantings
- Prefers well drained soils, poor in heavy soils

M.9 RN 29

- Clone of M.9
- Developed in Belgium by Rene Nicolai and released by Michelle Nicolai.
- Has performed very well in European tests. Under evaluation since 1992 in Michigan.
- Currently under evaluation in Michigan and other sites. Has performed better than NAKB 337.
- Popular rootstock for use in Tall systems; upper vigor M.9

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Limited (Availability) and Experimental Stocks

- **Supporter Series**
  - From Czech Republic
  - Available commercially and sold as Supporter 1, 2, 3 (M.9 vigor) and 4. Only 4 is being sold in any larger quantities; M.26 size
  - **Spptr 4**
    - M.26 size in vigor
    - More productive than M.26
    - Susceptible to FB
    - OK thus far on Cold Hardiness
- **Polish Series**
- **P.2 (http://www.nc140.org/domotorstock98.htm)**

  35-40%; M.9 in vigor

  Very early bearing, very productive, Needs support Needs further testing

  Well drained soils, Resistant to Phytophthora, Moderately susceptible FB

  Very little suckering; few burrknots2.

  Susceptible to tomato ringspot virus3

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Gala / B.9 after 9 yrs

Gala / N.337 after 9 yrs

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Dr. Jim Cummins, NYAES, Geneva, NY

Breeding and Developing New Apple Rootstocks by Dr. Jim Cummins Established in 1968, Geneva, NY (NYAES) Goals; Develop new rootstocks resistant to Fireblight, Phytophthora and Wooly Apple Aphids and still be as productive and precocious as Malling stocks

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Cornell-Geneva Apple Rootstock Breeding Program

GENNARO FAZIO

- Research Geneticist, USDA – ARS, 2001
- Adjunct Assistant Prof. Hort.Sci. Dept.
- Cornell Univ., Geneva, NY
- Department of Hort.Sciences
  New York State Ag. Exp. Sta.
- Cornell University
  Geneva, NY 14456
  Telephone: (315)-787-2480
- Email: gfazio@pgru.ars.usda.gov
  Gf35@cornell.edu
- http://www.ars.usda.gov/pandp/people/people.htm?personid=24554

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Size 1	Size 3	Size 5	Size 7	Size 9
M.27	M.9	G.30	MM.106	P.18
P.22	P.2	G.935	CG.7707	
G.65	G.41	CG.5087		
	G.16	CG.5179		
		CG.5757		

Size 2	Size 4	Size 6	Size 8	Size 10
B.9	M.26	M.7	MM.111	Sdlng
Mark	G.11	CG.6210	CG.8534	
P.16	G.202			
	CG.4013			
	CG.4213			

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Geneva Apple Rootstocks - Commercial Releases

Rootstock	Tree Size
Geneva®65 (G.65)	M.27 size
Geneva®30 (G.30)	M.26-M.7 size
Geneva®16 (G.16)	M.9 size
Geneva®11 (G.11)	M.9 size
Geneva®202 (G.202)	M.26 size
Geneva® 41 (G.41)	M.9 size
Geneva® 935 (G.935)	M.26 size

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Fireblight and Apple Rootstocks

- One of the major concerns for growing apples on clonal rootstocks in the Midwest and Eastern U.S.
- Most of the standard dwarfing rootstocks are highly susceptible.
- Canopy shoots can be infected and the bacteria spread and travel via the vascular components throughout the canopy and to the roots.
- Highly susceptible scion varieties such as Gingergold, Gala, Fuji, and Honeycrisp can become more susceptible on these rootstocks, especially M.26.
- Field and scientific studies have demonstrated that infections of susceptible varieties are slowed in pathogenesis on Bud.9. This phenomenon is not understood since the rootstock itself is susceptible.

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Fireblight infections in canopy stop when Bud.9 is the rootstock

Gala / B.9

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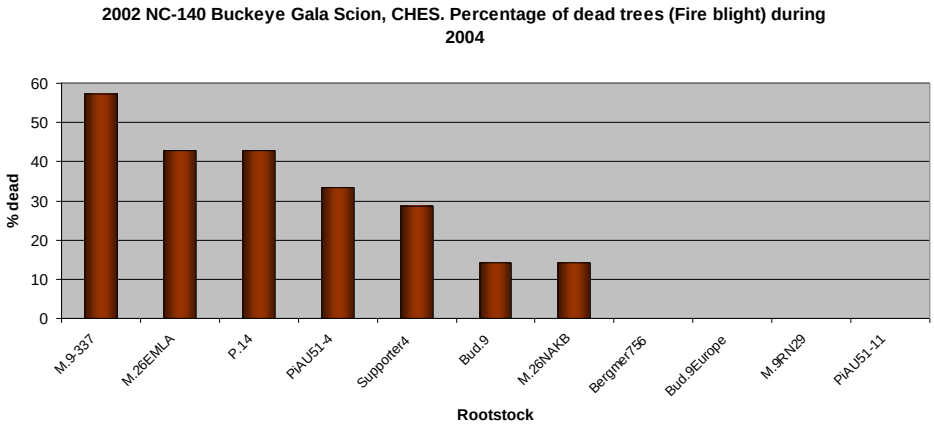
Fireblight Infection in 2004



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Cherry Rootstocks

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Cherry

- Clonal stocks (older)
  - F 12/1 Mazzard- extreme vigor
  - Colt - too cold sensitive, not dwarfing
  - Stockton Morello -virus affinity
- Seedling stocks -moderate to great variability

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Standard Cherry Rootstocks

P. Mahaleb	P. Avium
"Mahaleb"	"Mazzard seedling"
Used > 1768 A.D.	Since 400 A.D.
10-15 % smaller	Vigorous
little to suckering	suckers - variable; more in shallow soil
cold hardy (8 deg. F +)	moderately cold hardy
Compatible with Mont and some sweets	Compat with Mont and all sweets
Susceptible to Phytoph	Fairly tolerant
Susceptible to wet ft. and Armillaria	More tolerant of wet ft. and Armillaria
More Precocious	Less Precocious
Less Efficient in Uptake of B, N, MG, Mn	
More efficient in Uptake of Zn & Fe	

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Clonal Contemporary Stocks

MxM series

- -Developed in Oregon
- -Natural hybrids of Mahaleb x Mazzard -# 2 & 60 best
- wide range of compatibility little or no suckering productive (similar to Mahaleb) vigor > Mazzard 14 -70% of Mazzard

Gisela Series

- From Germany
- Gi 5 70% of standard
- Gi 6 75% of standard
- Gi 12 70 % of standard

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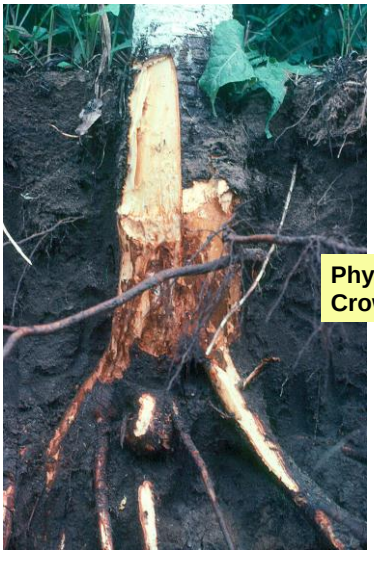
Tree health and performance affected by soil depth and maladies

Tart cherry / Mahaleb sdlng; root systems restricted in depth by clay subsoil

Hort

Shallow rooting and Phytophthora root and crown rot



Phytophthora Crown rot

Phytophthora on Mahaleb Cherry root system

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New Clonal Rootstocks

MxM series

- -Developed in Oregon
- -Natural hybrids of Mahaleb x Mazzard
- -# 2 & 60 best
- wide range of compatibility little or no suckering productive
- Clonal
- MXM 2 less productive than MxM 60, but best stock for heavy, shallow soils
- Both are more productive than Mazzard for sweets
- Both less productive than Mahaleb for Mont (more than Mazzard).
- MxM 2 most vigorous.

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Gisela Series

From Giessen, Germany

The clones that have demonstrated PD and PNRSV resistance (G. Lang), are the ones being recommended for commercial use.

- **Gi 5 P. Cerasus x Canescens**
  - **50- 70% of standard**
  - **Slightly less precocious than Gi. 6**
  - **problems after 4 years with runting and stunting**
- **Gi 6 P. Cerasus x Canescens**
  - **60- 100%* of standard**
  - **Precocious, problems after 4 years with runting and stunting**
- **Gi 12 P. Canescens x Cerasus**
  - **80 % of standard**
  - **Has not been trialed in Michigan**
  - **See G. Lang for experience in Washington**

*** Depends on site and soil conditions**

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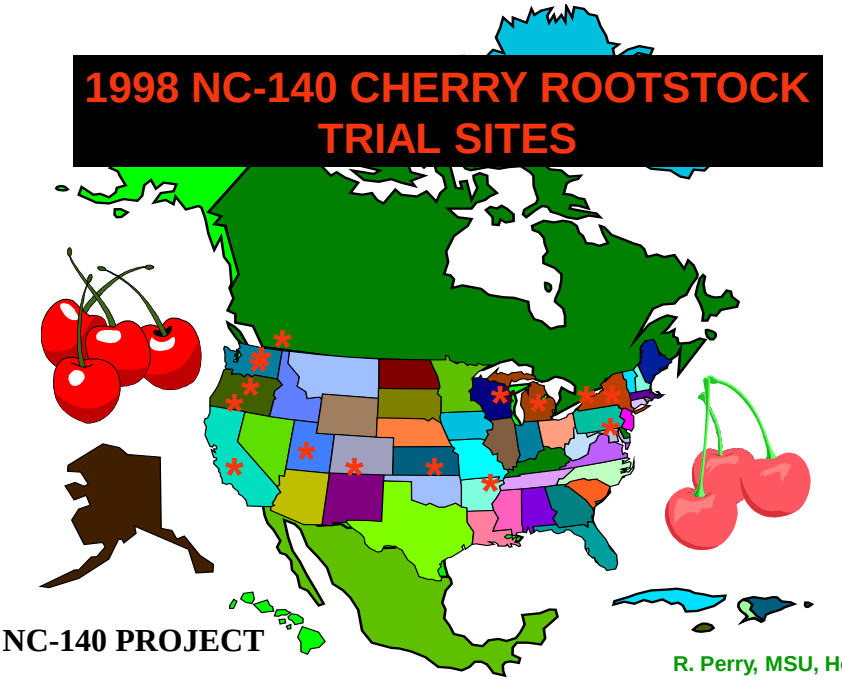
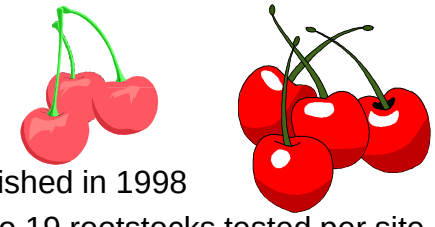


1998 NC-140 Cherry Rootstock Trial



- Established in 1998
- Eight to 19 rootstocks tested per site
- Trees planted in Randomized Blocks
- Generally eight replications per rootstock
- Bing in the West, Hedelfingen in East and Montmorency
- Cooperators across North America
- Trial Coordinators; F. Kappel and G. Lang

NC-140 PROJECT
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Cherry rootstocks under current test in 1998 NC-140 trials*

Prunus parentage	Rootstock
P. avium	Mazz
P.avium x fruticosa	Gi.473/10 (Gi.4)
P.cerasus	Tabel Edabriz', 'Weiroot 10 (W.10), W.13, W.53, W.72, W.154, W.158
P.cerasus x canescens	Gi.5, Gi.6, Gi.7, Gi.209/1
P.canescens x avium	Gi.318/17
P.canescens x cerasus	Gi.195/20
P.mahaleb	mahaleb
P.pseudocerasus	P.50, Colt

* From Lang, G. 2000. HortTechnology 10(4):719-725

** Gi.209/1 is same as Gi.3, Franken-Bembenek, Act Hort 658:

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General tree size of sweet cherry based on vigor classifications in PNW*

	Relative to Mazz	Rootstock
Very Dwarfing	35-50	"Inmil", Gi.1
Dwarfing	50-65	Damil', 'Gi.5', 'Gi.7', 'Gi.8', 'Gi.172/7', 'Gi.10'
Semidwarfing	65-80	Gi.154/7', 'Gi.169/15', 'Gi.11', 'Gi.12', 'Camil', 'MxM.14'
Vigorous	80-100	Mazz, mahaleb, 'MxM.39', 'MxM.60', 'Gi.6', 'Gi.196/4'
Very Vigorous	100+	Colt', 'MxM.60'
* From Lang, G. 2000. HortTechnology 10(4):719-725		

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Rootstock tolerance or sensitivity to pollen borne viruses (PDV and PNRSV)*.

	Rootstock
Tolerant	**Mazz, mahaleb, 'Colt', 'Gi.5', 'Gi.6', 'Gi.12', 'Gi.169/15', 'Gi.196/4', 'Inmil', 'Damil', 'MxM.2', 'MxM.60'**
Sensitive	Gi.7', 'Gi.8', 'Camil'
Hypersensitive	Gi.1', 'Gi.4', 'Gi.10', 'Gi.11', 'Gi.154/4', 'Gi.154/7', Gi.172/7'

* From Lang, G. 2000. HortTechnology 10(4):719-725

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Peach Rootstocks

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Peach Rootstocks

General History

Seedlings of P. persica
- -little differences and benefits

Lovell and Halford (California) -dry , canning peaches

Bailey (Iowa) -cold hardy & resists lesion nemas -West -Nemaguard and strains

South -Guardian (vigor) PTSLD

Others
- -Dwarfing -nursery trade Citation -plum x peach
- P. tomentosa - incompatible -30-40% -
- European clonals - experimental
- GF 677 (Amandier) Peach x Almond vigorous and productive
- Myran -Peach x Plum
- Myrabi -Plum x Plum hybrids (compatibility range narrow)

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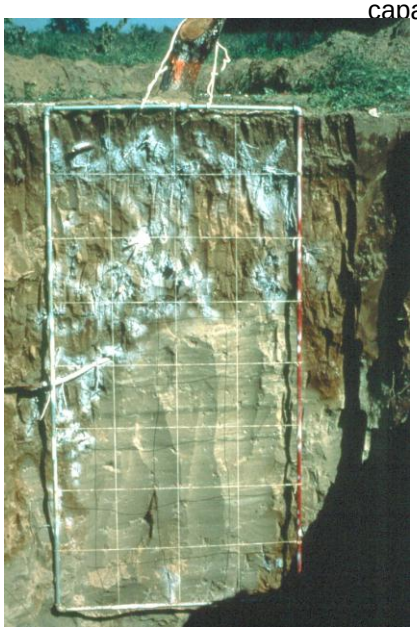
Soils historically limit peach rootsystems
And impact survival

Plant with union slightly
Above soil line

Peach roots prefer loamy soils with good CEC and moisture holding capacity



A Horizon

B Horizon with fine particles
Preferred for peach roots

Course alkaline sand
C Horizon; No roots

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Shallow rooting and Phytophthora root and crown rot

Peach roots limited by clay layer

Phytophthora
Crown rot

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Standard Seedling Rootstocks

1. Lovell
2. Bailey
3. Nemaguard
4. Stark's Red Leaf

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Lovell

- Origin: Winters, California, named in 1882 Parentage: Chance peach seedling
- Compatibility: Compatible with peach
- Propagation: Propagates sexually with high seedling uniformity
- Vigor: Vigorous
- Excellent compatibility and lack of suckering.
- Good productivity on good peach soils.
- Susceptible to root lesion and Rootknot nematodes.
- Recommended rootstock for short life sites in the southeastern US and for peach areas in the Mid- Atlantic states.

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Bailey

- Origin: West Branch, Iowa, circa 1890 Parentage: Seedling selection of P. persica
- Compatibility: Compatible with peach
- Propagation: Propagates sexually with good seedling uniformity
- Vigor: Medium vigor, less than Lovell in the Southeast
- Other: Known for its cold hardiness among P. persica. Tree and root system is slightly (3° C) less cold hardy than Siberian C. Fair tolerance to root lesion nematode.

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Nemaguard

- Origin: Fort Valley, Georgia in 1949, named in 1961
- Parents-c: Seedling (FV 2?S4- 1)
- Compatibility: Compatible with peach
- Propagation: Propagates sexually with good seedling uniformity
- Vigor: Vigorous, more so than Lovell
- Other: Resistance or tolerance to Meloidogne incognita and M.
- javanica nematodes.
- Suckers more than most peach rootstocks and is highly susceptible to peach tree short life in the Southeast.

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Stark Redleaf

- Origin: Stark Bro's Nurseries and Orchards Co.
- Parentage: Selection of a 'Tennessee Natural' type rootstock
- Compatibility: Compatible with peach
- Propagation: Propagates sexually
- Vigor: Similar to Lovell in the Southeast
- Other: Redleaf character to eliminate bud misses in nursery .
- Trademarked.

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Plum Rootstocks

Seedling stocks

- Myrobalan 29-C (*P. Cerasifera*)
- S & W- Peach (Halford, Nemaguard, Lovell)
- Myro - tomato ring spot "Brown Line' virus induced delayed incompatibility

Clonal stocks (tolerate wet feet)

- -Marianna (P. cerasifera x munsoniana)
- 2624 -resists Brown Line,
  - Armillaria, moderate suckering

Brompton (*P. domestica*)

St. Julien (*P. insititia*)

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Apricot Rootstocks

Seedling stocks

- Apricot- Goldcot, Hagith, Manchurian, Blenheim (California)

Clonals

- Marianna 2624 -for heavy soils & Armillaria Citation
- Peach x Plum -experimental

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Pear Rootstocks

Clonal

- a. Quince A -G (*Cydonia oblonga*) 'Provence' 90% of French trees on A, B or C
- Susceptible to cold and fireblight
- Moderate Compatibilitly with Bosc, Winter Nellis, Hardy Seckel
- Incompatible with Bartlett, Anjou Kieffer, Comice
  - Use Interstock of Old Home
- Bartlett -cannery run older trees in California
- *P. Betulaefolia*
- *P. Calleryana* (Southern US)

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1. OHxF97
    1. European, Asian and flowering pears. Vigorous, widely adapted, disease-resistant, winter hardy, & tolerant of wet soils.
2. OHxF333
    1. European and Asian pears are dwarfed to about 2/3 the size of standard, or about 12-15 ft. Widely adapted & disease-resistant.
3. *Pyrus Betulaefolia*
    - Asian pears. Very vigorous, tolerates wet soil, dry soil, alkaline soil. Resists pear decline. More vigorous than Calleryana, and more winter hardy.
4. *Pyrus Calleryana*
    - For flowering pears and Asian pears. Asian pears precocious.

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