

What Exactly Is a Pomegranate Cultivar?

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National Clonal Germplasm Repository

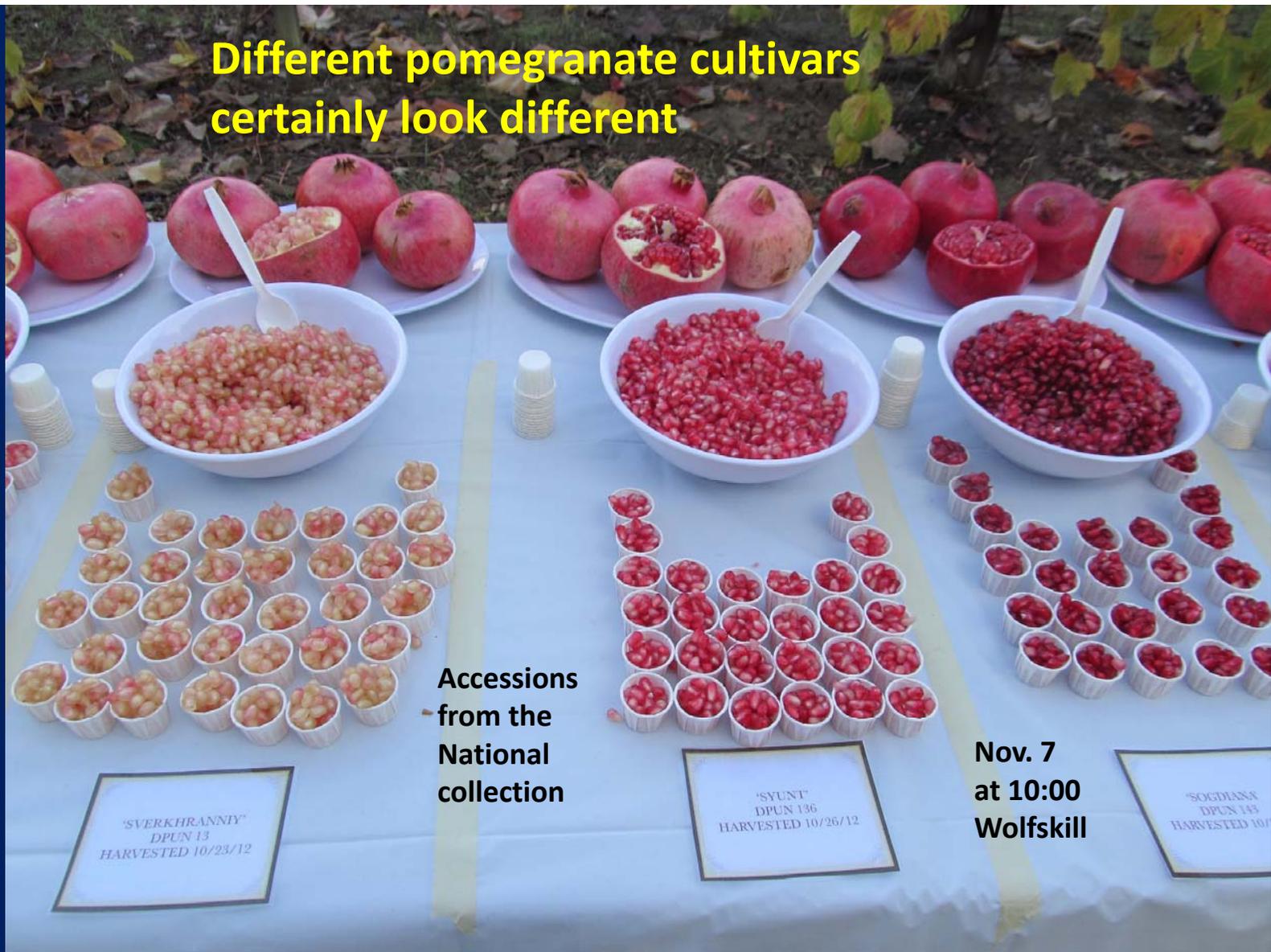
Davis, CA

USDA-ARS



USDA

**Different pomegranate cultivars
certainly look different**



**Accessions
from the
National
collection**

*"SVERKHRANNY"
DPUN 13
HARVESTED 10/23/12*

*"SYUNT"
DPUN 136
HARVESTED 10/26/12*

**Nov. 7
at 10:00
Wolfskill**

*"SOGDIANN"
DPUN 143
HARVESTED 10/26/12*

The National Clonal Germplasm Repository for Mediterranean Tree Fruits, Nut Crops, and Grapes



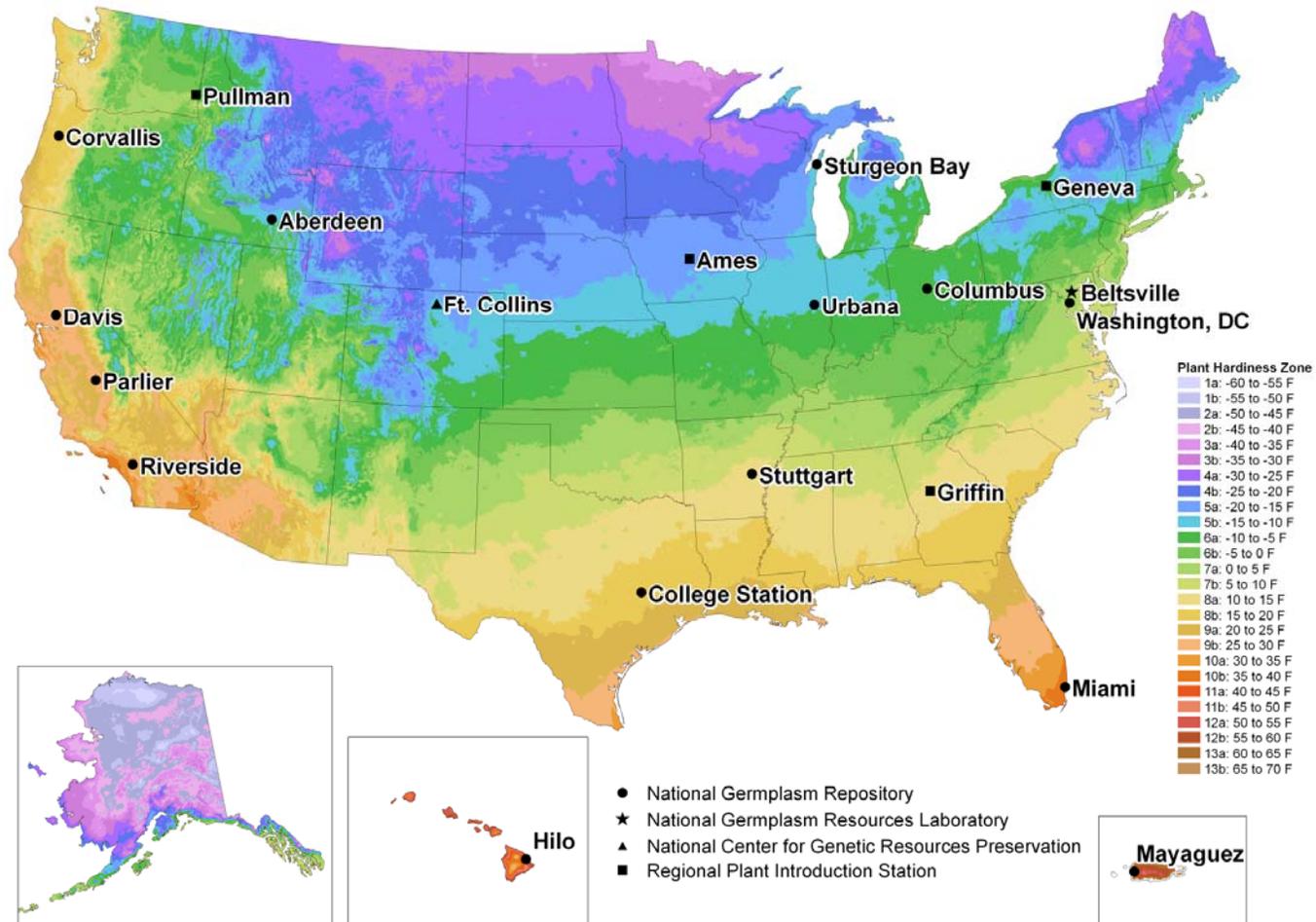
NATIONAL CLONAL GERmplasm REPOSITORY
FOR FRUIT AND NUT CROPS





Jeff Moersfelder, Pomegranate Horticulturist

National Plant Germplasm System



Mission

Acquire
Preserve
Evaluate
Distribute

Tree fruits, nut crops and grapes



NATIONAL CLONAL GERmplasm REPOSITORY
FOR FRUIT AND NUT CROPS





NCGR-Davis Nursery





Wolfskill Experimental Orchard



The Collection

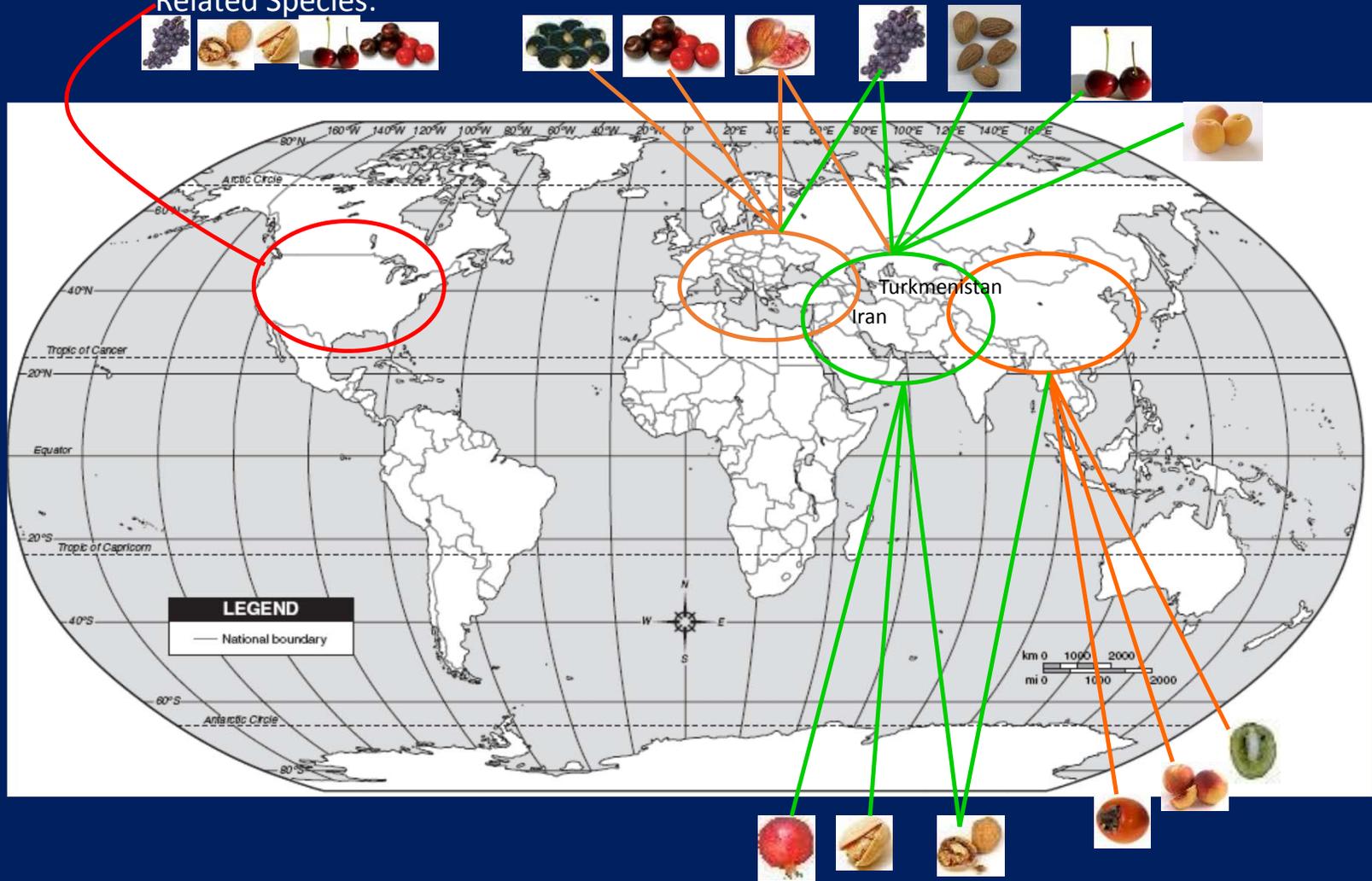
No Patented Cultivars
Heirlooms
Breeders' Selections
Wild Forms/Relatives

Current status of collection

• Grape (<i>Vitis</i> spp)	~50 taxa	3611 accessions
• Almond/Stone fruit (<i>Prunus</i> spp.)	>90 taxa	1457 accessions
• Walnut (<i>Juglans</i> spp.)	23 taxa	646 accessions
• Pistachio (<i>Pistacia</i> spp.)	14 taxa	334 accessions
• Olive (<i>Olea</i> spp.)	3 taxa	148 accessions
• Fig (<i>Ficus</i> spp.)	5 taxa	302 accessions
• Pomegranate (<i>Punica granatum</i>)	1 taxon	281 accessions
• Persimmon (<i>Diospyros</i> spp.)	3 taxa	133 accessions
• Mulberry (<i>Morus</i> spp.)	4 taxa	58 accessions
• Kiwifruit (<i>Actinidia</i> spp.)	14 taxa	78 accessions
• Loquat (<i>Eriobotrya</i> spp.)	2 taxa	35 accessions
• <i>Ampelopsis</i> spp.	7 taxa	21 accessions

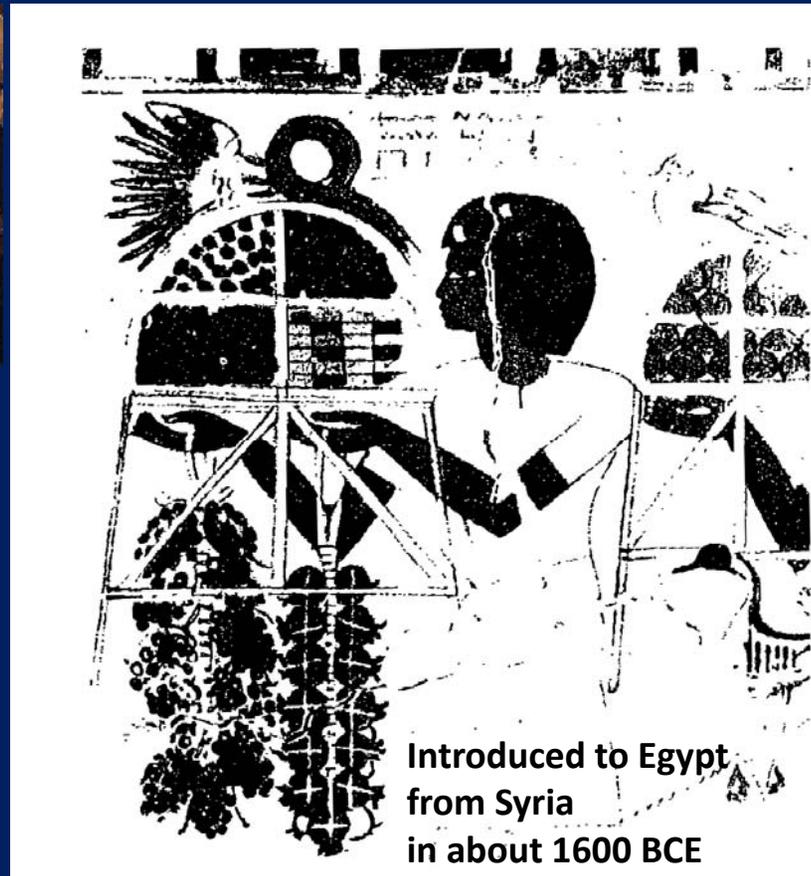


Related Species:



Origin and Diversity of Fruit and Nut Species at the Davis Repository

Ethnobotany: Millennia of human cultivation of pomegranate



Introduced to Egypt
from Syria
in about 1600 BCE



Royal College of
Physicians

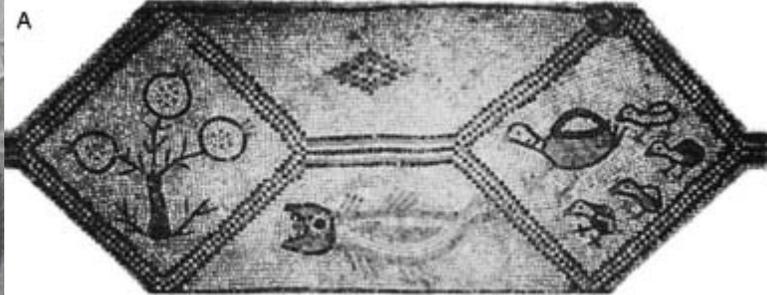
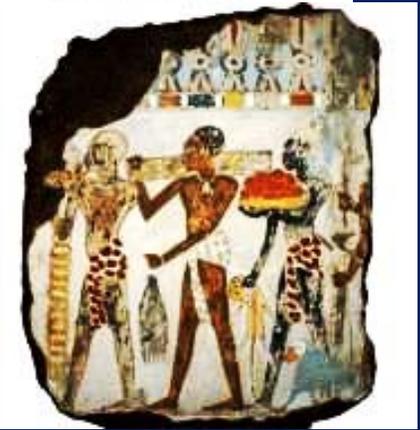


Fig. 6. (A) Mosaic from the synagogue at Beth Aïfashowing a pomegranate tree, birds, and fish. (B) Jewish coins, ancient and modern, with pomegranate motif. Source: Goor and Nurock, 1968.





TWO TREES, ONE GARDEN



Religious significance

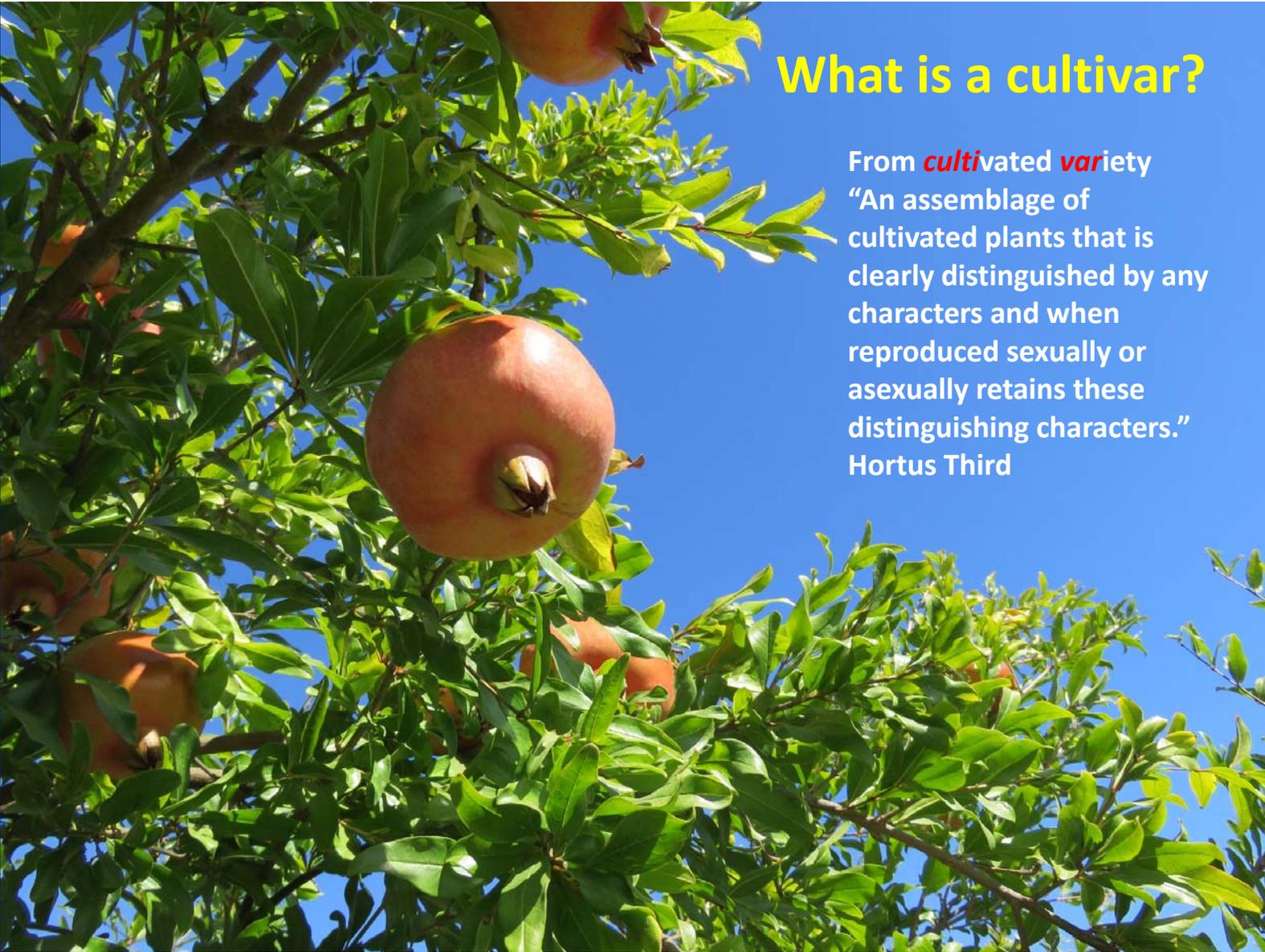
Table 1. Number of chapters in Hebrew and Christian bibles that refer to specific fruits cited by Moldenke and Moldenke (1952) and number of mentions in the Qur'an (Shakir, 1983)

Crop	Hebrew Bible	Christian Bible	Qur'an	Total
Pomegranate*	23	0	3	26
Almond*	10	0	0	10
Apple	5	0	0	5
Date	34	8	22	64
Fig (two species)*	37	13	1	51
Grape*	72	6	12	90
Olive*	48	12	6	66
Walnut*	1	0	0	1

*In the collection at the National Clonal Germplasm Repository, Davis, CA

The History of the Pomegranate Collection (281 accessions from 11+ countries)

- **50+ years ago** the trees that make up the “old block” C came from the **Chico Plant Introduction Station** and were accessioned in 2013.
- **Pre 1990** “new block” A was planted with 5 (mostly **ornamental accessions**)
- **1990** received 5 **Japanese ornamental cultivars**
- **1995** received 7 accessions collected from the **Turkmenistan Experimental Station of Plant Genetic Resources, Garrygala** by Dr. George White and Dr. Dan Parfitt
- **1996** received 19 accessions of various backgrounds from **Todd Kennedy**
- **1996 + 1997** received 15 accessions from **John LaRocca and John Chater**
- **1997** received 22 accessions from Michael Hotchkiss in **Byron, Georgia**, 17 originally came from **Turkmenistan** and 5 from the **Safiabad Research Center in Iran**.
- **1999** received 65 accessions from **Dr. Gregory Levin at the Turkmenistan Experimental Station of Plant Genetic Resources, Garrygala** with cooperation from William R. Feldman, Boyce Thompson Southwestern Arboretum
- **2006** received accessions from **The Republic of Georgia** and 11 from **Armenia** collected by Dr. Ed Stover and Joseph Postman
- **2006** received 5 accession with various backgrounds from **David Silverstein**
- **2007** received accessions from **India** from Dr. Dharam Sharma
- **2007** received 16 accessions from **Azerbaijan** collected by Dr. Malli Aradhya
- **2011** received 5 accessions from **Albania** collected by Dr. John Preece, Joseph Postman, and Endrit Kullaj



What is a cultivar?

From *cultivated variety*
“An assemblage of cultivated plants that is clearly distinguished by any characters and when reproduced sexually or asexually retains these distinguishing characters.”
Hortus Third

Ornamental Cultivars



'Haku Botan'



'Ki Zakuro'



'Dotch Legrelley'



'Toryu Shibori'

All cultivated plants were derived from wild forms

September hillside of wild pomegranates in Albania



Natural drought tolerance

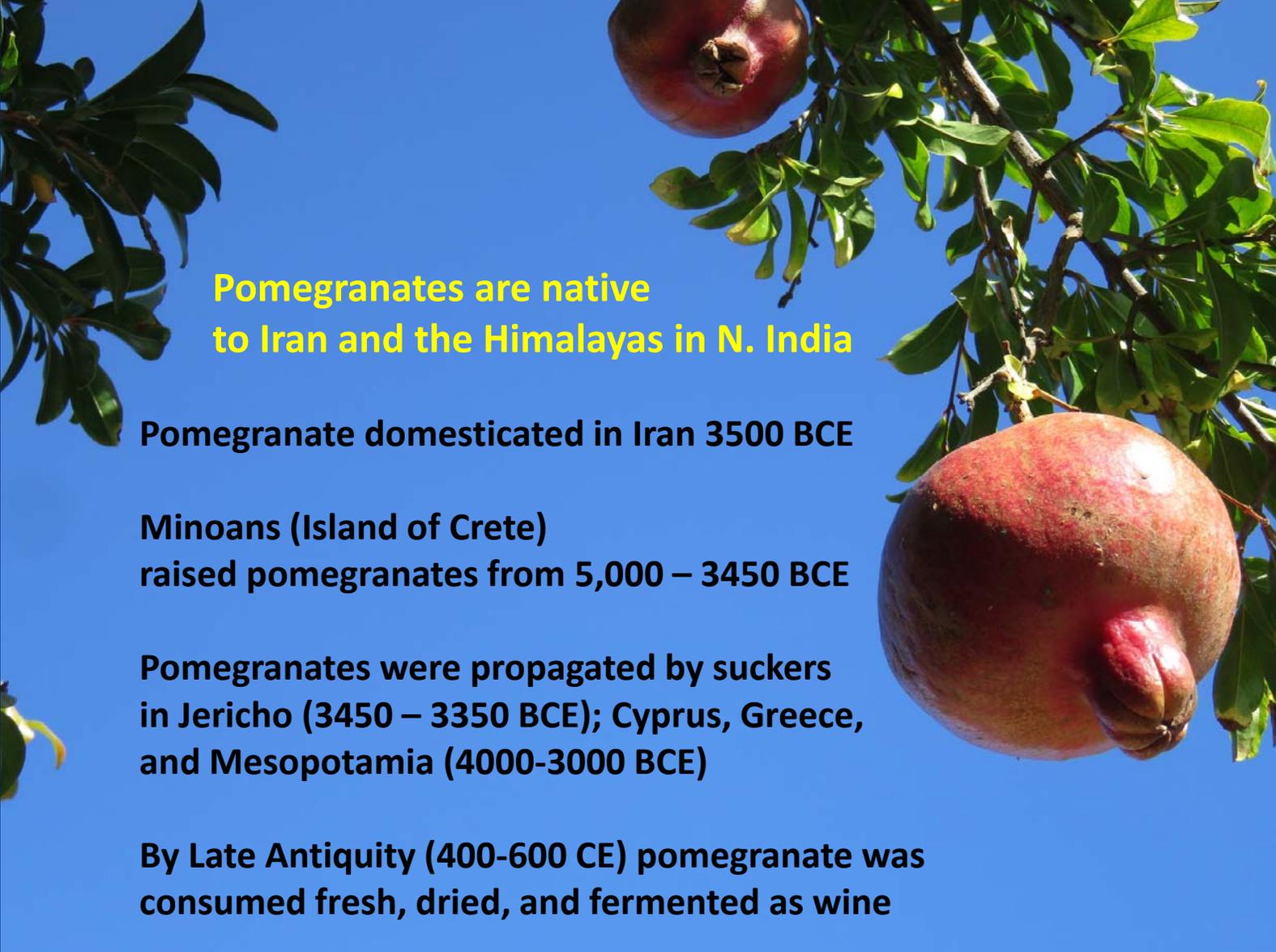




Small, sour wild fruit with hard seeds



Gathering, then landraces and selections from nature

A photograph of a pomegranate tree branch with several ripe, reddish-brown pomegranates hanging from it. The leaves are green and glossy. The background is a clear, bright blue sky. The image is framed by a dark blue border on the left and right sides.

**Pomegranates are native
to Iran and the Himalayas in N. India**

Pomegranate domesticated in Iran 3500 BCE

**Minoans (Island of Crete)
raised pomegranates from 5,000 – 3450 BCE**

**Pomegranates were propagated by suckers
in Jericho (3450 – 3350 BCE); Cyprus, Greece,
and Mesopotamia (4000-3000 BCE)**

**By Late Antiquity (400-600 CE) pomegranate was
consumed fresh, dried, and fermented as wine**

Plant Breeders

John Chater,
343 Gardenia Ave.,
Camarillo,
California 93010
TEL. 1-(805) 484-0696

20% off or free shipping to
C.R.P.G. Members

303 Gardenia ave.

TAKE CARMEN OF THE 101 FREEWAY NORTH
STAY RIGHT ON CARMEN TO CROSS LAS POSAS
TURN LEFT ON TAMARIX ABOUT 100FT. AND
TURN RIGHT ON GARDENIA TB NO. 343.

Lantana
POSAS
CARMEN DR.
Tamarix

TO OXNARD 101 FREEWAY to L.A.





Male and Female Flowers



Male and Female Flowers



Male and Female Flowers - Split







Por
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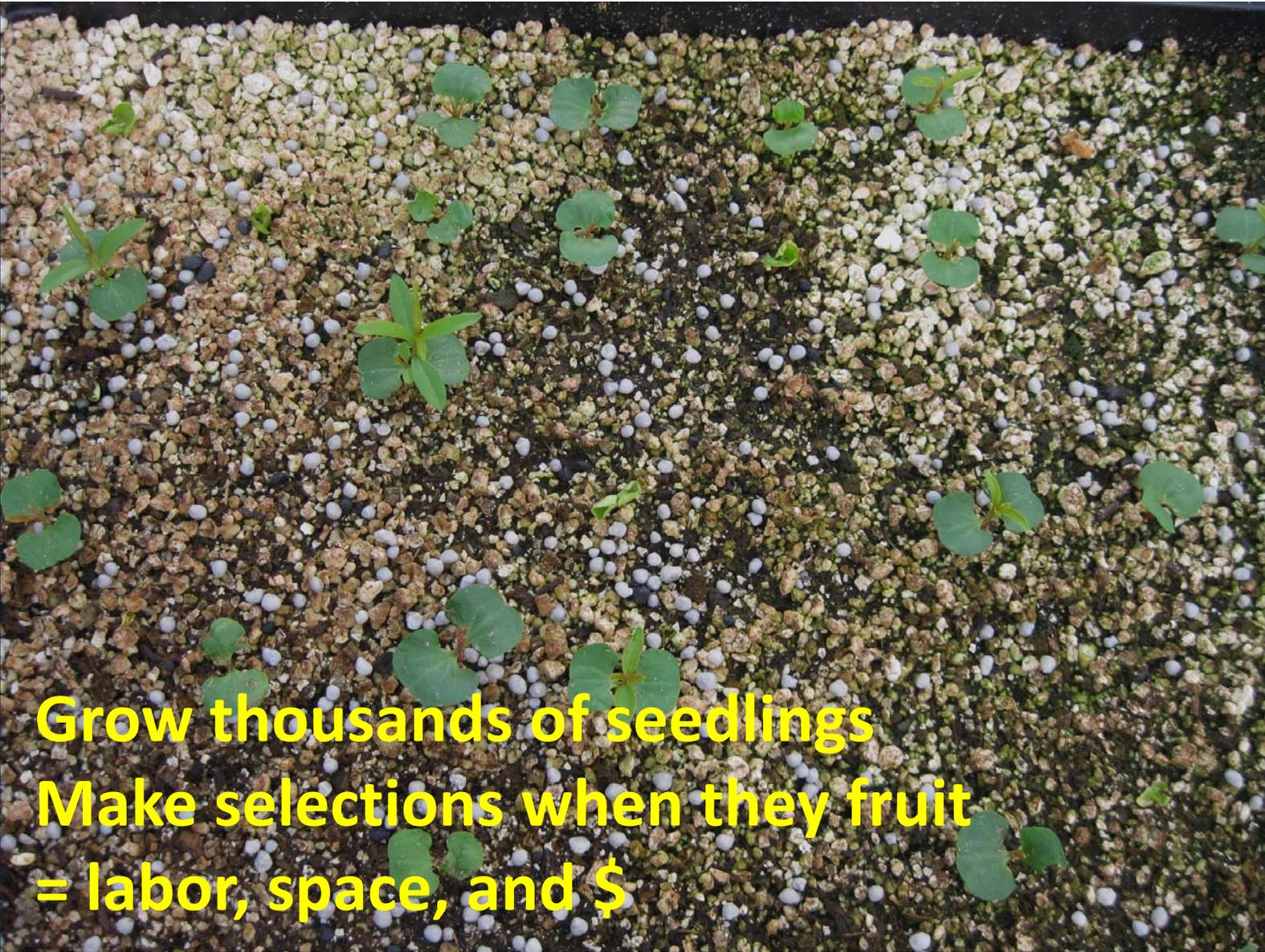
10/12/2015



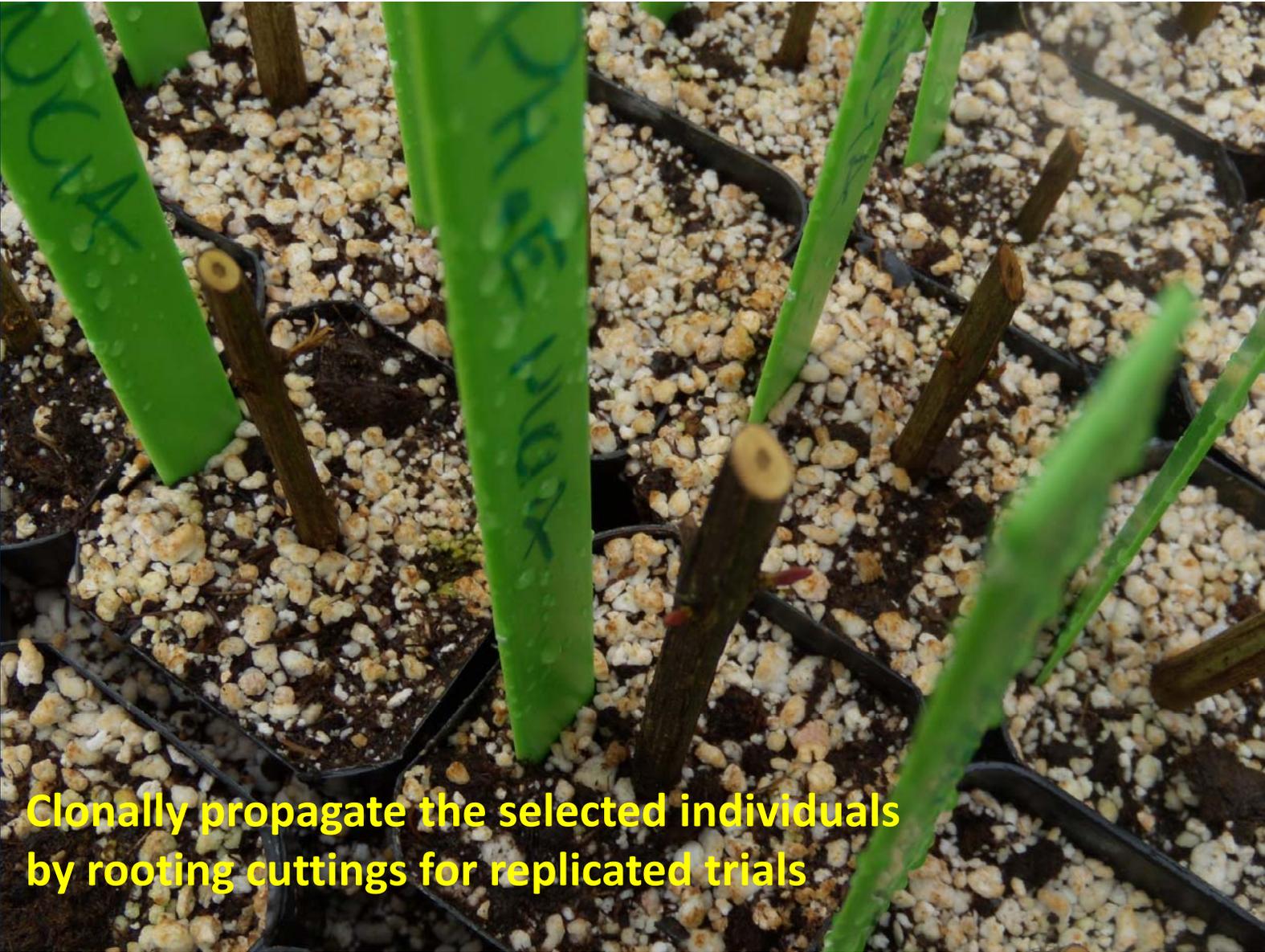
0.1% pectinase added to fruit-seed-water and pulp at a 1:40 ratio for 24 hr (Rao et al., 2006)







**Grow thousands of seedlings
Make selections when they fruit
= labor, space, and \$**



Clonally propagate the selected individuals by rooting cuttings for replicated trials

Collecting dormant pomegranate cuttings at the Repository





15 second dip in
3000 ppm auxin
(2000 ppm IBA +
1000 ppm NAA)

Cuttings are stuck in
1 perlite: 1 coarse
vermiculite, under
mist



Pomegranates under mist



Cuttings Ready for Potting









Desirable traits for breeding new pomegranate cultivars

Fresh vs. juice

- Sweetness
- Tartness
- Seed hardness
- Disease resistance (*Alternaria* and *Aspergillus* fruit rot, and gray mold, *Botrytis*)
- Splitting
- Sunburn
- Suckering
- Antioxidants, vitamins, etc.



Splitting =
Nature's
way of
dispersing
seeds

Splitting
varies among
cultivars



Rind thickness?





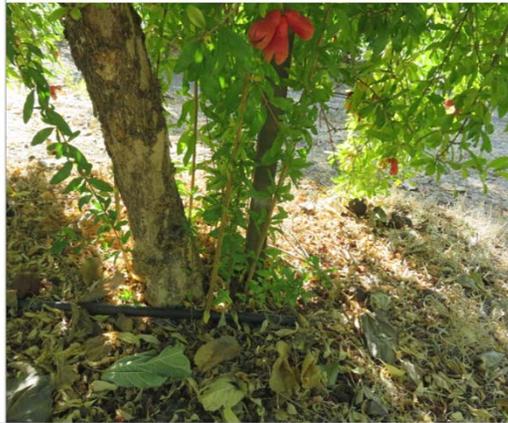
**Wild pomegranates in their native arid climates,
with dry leaves, fine twigs, and a suckering, bush-like habit
provide ample fuel for wild fires**

Selected by nature to burn and survive





This fire in Iran burned wild,
sour pomegranates. Fire is a
natural part of their ecology.
Suckers = survival



Suckering
varies among
cultivars

Pruning = \$

A breeding
goal?

Juice color



Aril and rind colors and characteristics



Haku-botan (DPun 7)



Fleischman (DPun 28)



Salavatski (DPun 62)



Nikitski Ranni (DPun 67)



Sin Pepe (DPun 82)



Myagkosemyannyi Rozovyi (DPun 139)



Nusai (DPun 145)



Ovadan (DPun150)



Kara Gul (DPun155)



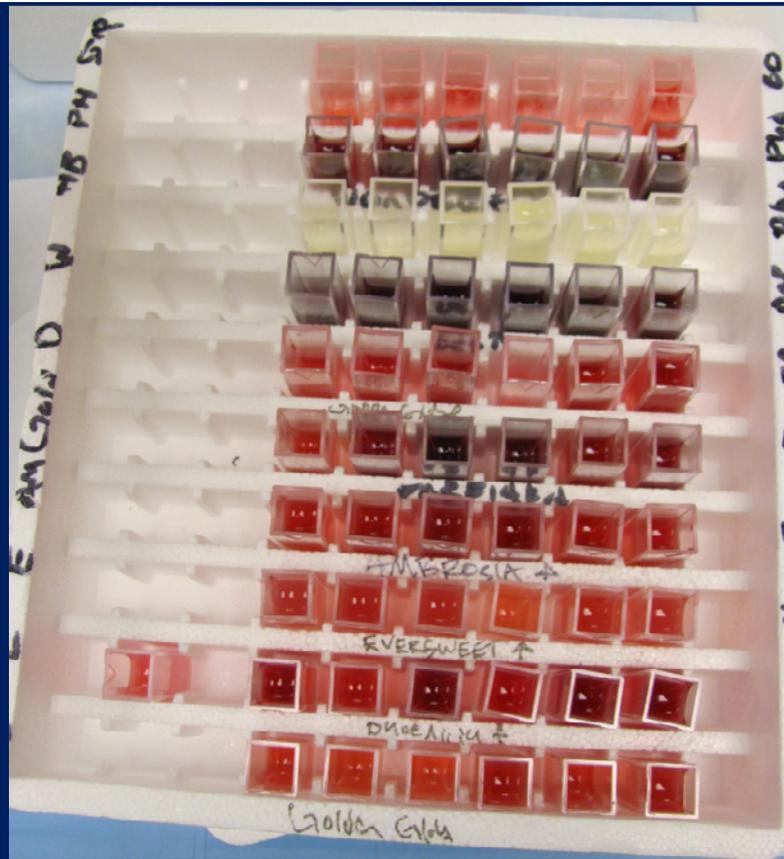
Wonderful (DPun 81)

Beaulieu, J. C., S. W. Lloyd, J. E. Preece, J. W. Moersfelder, R. E. Stein-Chisholm, and J. M. Obando-Ulloa. 2015. Physicochemical properties and aroma volatile profiles in a diverse collection of California-grown pomegranate (*Punica granatum* L.) germplasm. Food Chemistry 181: 354-364.

Characteristics of pomegranate (*Punica granatum* L.) germplasm (cultivars) assessed for juice attributes

Cultivar	Germplasm Code ¹	Country of Origin	Acidity, Tart, Sourness ²	Flavor ²	Skin Color ²	Aril Color ²
Haku-botan	DPUN0007	Japan	Highest	Sour; sweet-tart	Yellow	White to clear-yellow
Fleischman	DPUN0028	Unknown ^y	Low-medium	Very sweet, mild-fruity	Pink	Pink
Salavatski	DPUN0062	Turkmenistan	Low	Sweet-mild	Yellow-pink	Deep red
Nikitski ranni	DPUN0067	Turkmenistan	Low-medium	Sweet aromatic	Red-pink	Red
Sin Pepe	DPUN0082	USA	Low	Sweet-mild	Yellow-pink	Pink-red
Myagkosemyannyi Rozovyi	DPUN0139	Turkmenistan	High	Sweet-astringent	Yellow-pink	Pink
Nusai	DPUN0145	Turkmenistan	Low	Sweet-tart	Pink	Pink
Ovadan	DPUN0150	Turkmenistan	High	Sour-earthy	Red	Deep red
Kara Gul	DPUN0155	Turkmenistan	High-Tart	Sweet-tart; flavorful	Dark red	Deep red
Wonderful	DPUN0081	USA	Medium-high	Sweet-tart/ Sweet-sour	Red	Red
Commercial Wonderful ^z	PW-1	USA	Medium-high	Sweet-tart	Red	Red

From: Beaulieu, et al. 2015. Food Chemistry 181: 354-364.



Chemical and physical characterization of the juice
in different germplasm cultivars from the NCGR-Davis.

Cultivar	Brix	TA	Brix:TA	pH	Juice color				
					L*	C*	a*	b*	hue
Haku-botan	15.90 [*] ₁	2.05 [*]	7.76 [*]	2.76 [*]	24.52 [*]	2.17 [*]	-1.02 [*]	1.91 [*]	-61.66 [*]
Fleischman	16.23 [*]	0.22 [*]	74.29 [*]	3.41 [*]	21.19 [*]	6.35 [*]	6.35 [*]	0.05 [*]	0.49 [*]
Salavatski	16.40 [*]	1.27 [*]	12.89	3.15 [*]	16.50	5.75	5.60	1.32	13.24
Nikitski Ranni	16.20 [*]	1.41 [*]	11.51	2.99	18.07	5.67	5.47	1.49 [*]	15.17
Sin Pepe	16.20 [*]	0.24 [*]	66.93 [*]	3.48 [*]	21.64 [*]	5.94 [*]	5.93 [*]	0.18 [*]	1.89 [*]
Myagkosemyannyi Rozovyi	15.90 [*]	1.14	14.09	3.11	20.44 [*]	6.58 [*]	6.57 [*]	0.37 [*]	3.14 [*]
Nusai	17.33	0.24 [*]	72.93 [*]	3.45 [*]	19.55	7.05 [*]	6.89 [*]	1.47 [*]	12.00
Ovadan	15.70 [*]	1.27 [*]	12.47	3.15 [*]	18.40	3.75	3.70	0.57	8.63
Kara Gul	16.33 [*]	1.86 [*]	8.78 [*]	2.91 [*]	17.88	3.85	3.78	0.75	11.43
Wonderful (81) ²	17.70 ^a	1.10 ^b	16.05 ^a	3.05 ^a	17.80 ^a	4.69 ^a	4.59 ^a	0.95 ^a	11.69 ^a
Com. Wonderful PW-1 ³	17.43 ^b	1.32 ^a	13.24 ^b	3.06 ^a	16.92 ^a	3.54 ^b	3.46 ^b	0.74 ^b	12.07 ^a

¹ Means highlighted with an * are significantly different from Wonderful DPun 81 (control) using Dunnett's method at $p < 0.05$. Means of Wonderful DPun 81 and commercial Wonderful (PW-1) not connected by same letter are significantly different according to Tukey-Kramer HSD at $p < 0.05$.

² Wonderful (81) = Germplasm control.

³ Com. Wonderful PW-1 = commercial PomWonderful fruit, Paramount Farms.

From: Beaulieu, et al. 2015. Food Chemistry 181: 354-364.

But some pomegranates are loaded with acid



Organic acid content in pressed juices of NCGR-Davis accessions

Pressed juice	Organic acid content (mg • mL ⁻¹)					
	Oxalic	Malic	Ascorbic	Citric	Fumaric	Total
Cultivar						
Haku-botan	m.s. ¹	m.s.	m.s.	m.s.	m.s.	m.s.
Fleischman	1,815.0 b	601.6a,b,c	12.0a	5,073.8d	0.4a	7,502.6c
Salavatski	381.7 c	596.9a,b,c	n.d. ²	22,067.3b	0.4a	23,046.2b
Nikitski Ranni	368.3 c	237.4c	n.d.	20,889.9b,c	0.4a	21,496.1b
Sin Pepe	1,384.1 b	506.0a,b,c	31.6a	5,888.2d	0.5a	7,811.1c
Myagkosemyannyi Rozovyi	285.3 c	266.8c	0.7a	18,136.1b,c	0.4a	18,689.3b
Nusai	2,329.0 a	1,150.8a	25.5a	3,713.3d	0.4a	7,755.5c
Ovadan	274.6 c	716.7a,b,c	n.d.	19,184.3b,c	n.d.	20,175.7b
Kara Gul	287.8 c	36.2b	57.7a	28,096.8a	0.2a	28,455.0a
Wonderful (81) ³	m.s.	m.s.	m.s.	m.s.	m.s.	m.s.
Com. Wonderful PW-1 ⁴	m.s.	m.s.	m.s.	m.s.	m.s.	m.s.
Com. Wond. - Arils pressed ⁵	346.7c	1,042.4a,b	n.d.	16,518.1c	0.4a	17,907.4b
Com. Wond. - ART residual ⁶	354.1 c	1,001.6 a,b	n.d.	19,798.8 b,c	n.d.	21,154.6 b

From: Beaulieu, et al. 2015. Food Chemistry 181: 354-364.



Differences in amount
of red = anthocyanins

Aril Characteristics



DPUN 0007 'Haku Botan'



DPUN 0082 'Sin Pepe'



DPUN 0107 'Gissarskii Rozovyi'



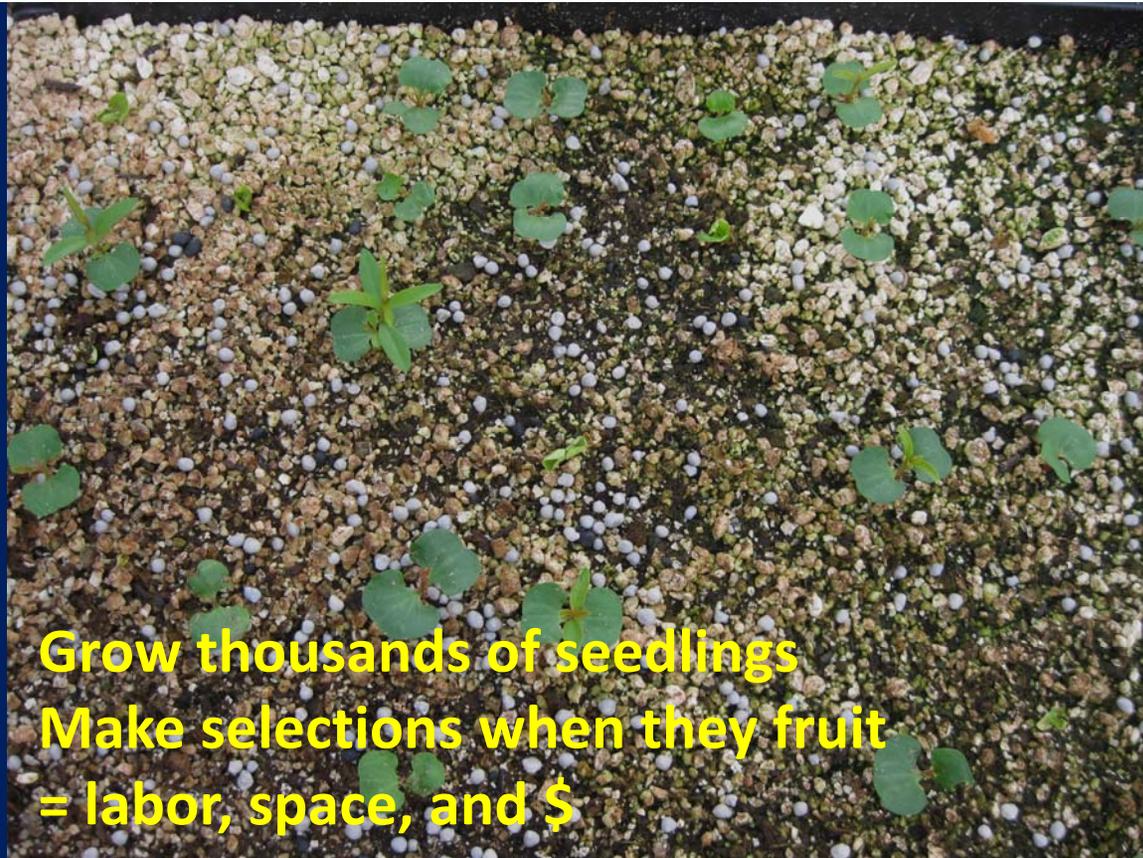
DPUN 0056 'Purple Heart'

Anthocyanidin content in the juices and whole fruit in different NCGR-Davis germplasm cultivars

Pressed juice Cultivar	Anthocyanidin content (mg • L ⁻¹ pressed juice)			
	Delphinidin	Cyanidin	Pelargonidin	Total
Haku-botan	0.08 * ¹	0.11 *	n.d. * ²	0.19 *
Fleishman	4.00 *	11.87 *	0.61 *	16.48 *
Salvatski	21.89	96.71 *	3.95 *	122.55 *
Nikitski Ranni	12.73	31.83 *	1.10	45.65 *
Sin Pepe	3.58 *	11.71 *	0.63 *	15.91 *
Myagkosemyannyi Rozovyi	2.85 *	6.99 *	0.33 *	10.16 *
Nusai	5.79 *	24.94 *	2.76 *	33.49 *
Ovadan	36.04 *	82.77	2.45 *	121.26 *
Kara Gul	29.61 *	68.37 *	2.17 *	100.15 *
Wonderful (81) ³	20.18 b	50.68 c	1.47 c	72.33 b
Com. Wonderful PW-1 ⁴	38.47 a	94.31 a,b	2.81 b	135.59 a
Com. Wond. - Arils pressed ⁵	18.10 b	58.96 b,c	1.89 b,c	78.96 b
Com. Wond. - ART residual ⁶	29.19 a,b	116.80 a	4.38 a	150.37 a

Whole fruit Cultivar	Anthocyanidin content (mg • Kg ⁻¹ fw)			
	Delphinidin	Cyanidin	Pelargonidin	Total
Haku-botan	1.33 *	3.33 *	n.d.	4.67 *
Fleishman	5.00 *	11.33 *	1.50	17.67 *
Salvatski	15.00	35.00	1.67	52.00
Nikitski Ranni	11.00	21.33	1.00 *	33.33
Sin Pepe	6.00	12.67 *	1.00 *	20.33 *
Myagkosemyannyi Rozovyi	3.33 *	8.67 *	1.10	12.67 *
Nusai	4.00 *	13.67 *	1.67	19.00 *
Ovadan	16.67	26.67	3.33	46.67
Kara Gul	9.00	34.33	3.67	47.33
Wonderful (81) ³	13.33 a	28.00 a	3.33 a	44.67 a
Com. Wonderful PW-1 ⁴	10.33 a	33.00 a	2.33 a	43.00 a

From: Beaulieu, et al. 2015. Food Chemistry 181: 354-364.



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Sweet_S = Sweet to sweet/Tart, pink to dark red, predominantly soft seeded

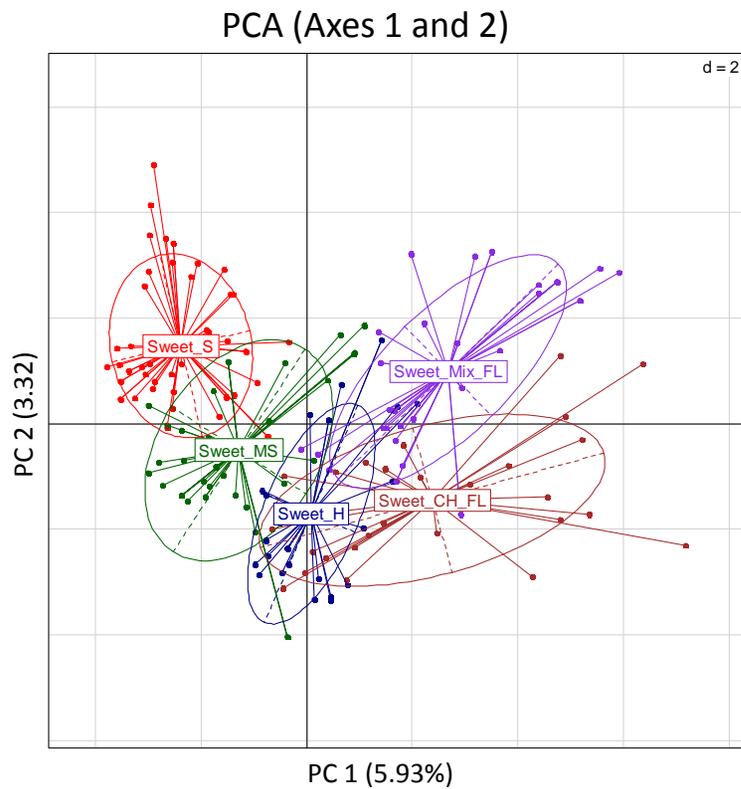
Sweet_MS = Sweet to sweet/Tart, pink to dark red arils, soft to medium seed, contains 'Wonderful' group.

Sweet_H = Sweet/tart, red arils, hard seeded, mostly cold tolerant, many varieties from Georgia

Sweet_CH_FL = Chater group contains sweet types, lower group contains sweet/tart types, contains Indian group. Included ornamental group are all short in stature (this may also be true for Indian group – not certain).

Sweet_Mix_FL = Sweet/ tart, medium to hard seed, many cold tolerant varieties including varieties from Iran. Also includes many ornamental types.

Note: Flower type



**Of course the proof is in the
tasting and marketing**





Thank

You!