Genetic Resources of the Sunflower Crop Wild Relatives for Resistance to Sunflower Broomrape

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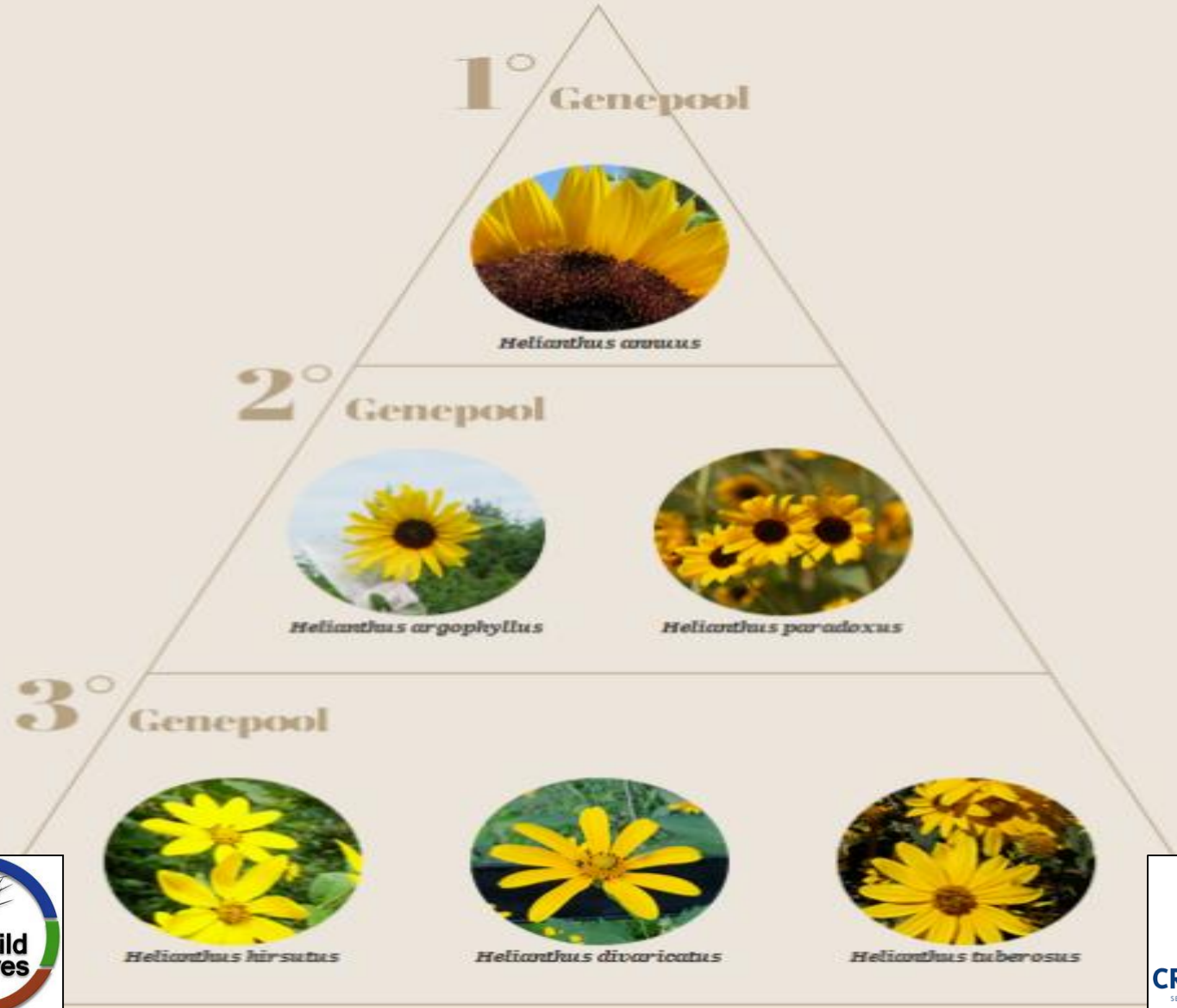
Outline

- Genetic diversity of wild species
- Broomrape resistance sources
- Future prospective

Sunflower Genepools



crop wild relatives

CROP TRUST
SECURING OUR FOOD, FOREVER

Sunflower Crop Wild Relatives

Cultivated (2n=2x=34)

14 annuals (2x=34)

39 perennials

29 wild diploids (2x=34)

4 wild tetraploids (4x=68)

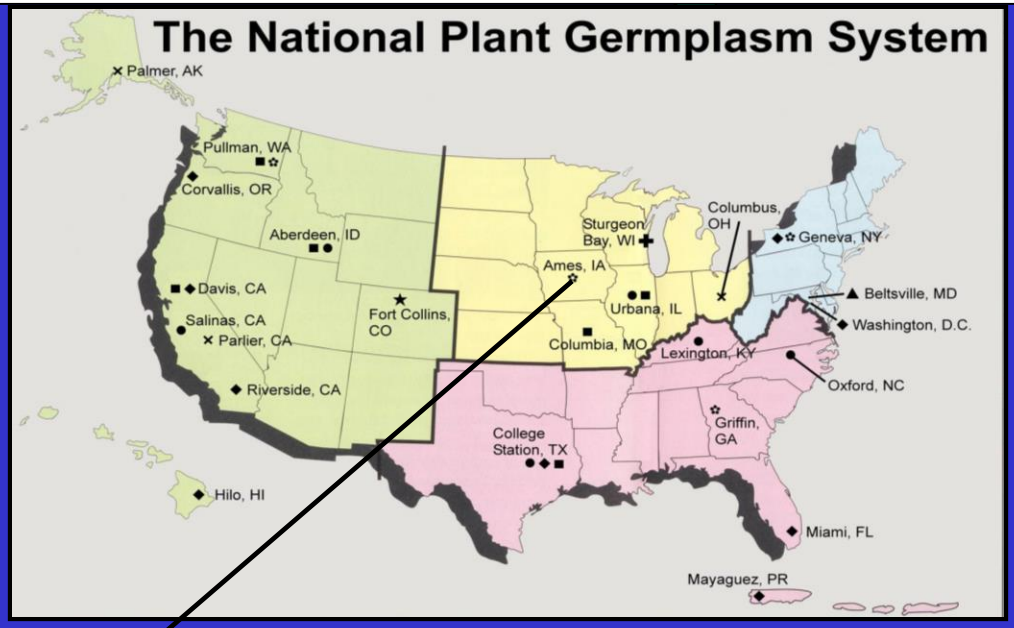
6 wild hexaploids (6x=102)

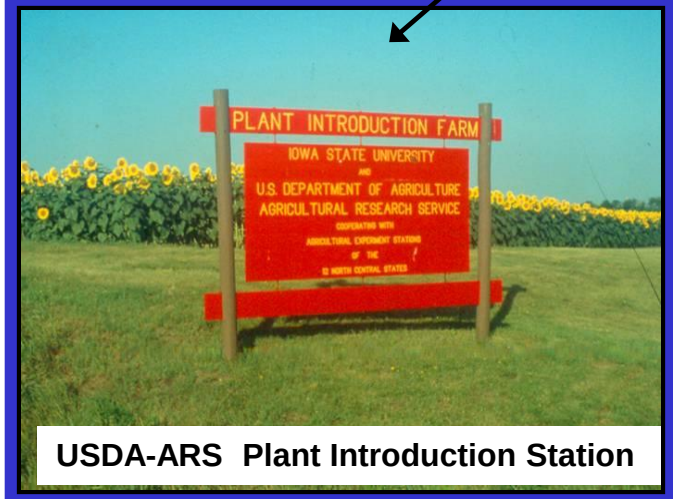
2 Mixaploid perennials (2n=2x=34, 4x=68)

2 Mixaploid perennials (2n=4x=68, 6x=102)

- All wild species can be hybridized with cultivated sunflower except *H. agrestis*
- F_1 abortion (embryo rescue)
- F_1 sterility (colchicine treatment)

USDA, ARS, North Central Regional Plant Introduction Station and Iowa State University, Ames, Iowa





USDA-ARS Plant Introduction Station

Laura Marek, Curator

Seed increase, Ames, IA

Accessions in the USDA-ARS Sunflower Collections

H. debilis, Florida

H. pumilus, Colorado

H. niveus, California

Type	Number	Available %
Cultivated	1886	92
Wild species	2201	87
Annual	1359	95
Perennial	842	70
Total	4087	88

Germplasm Requests

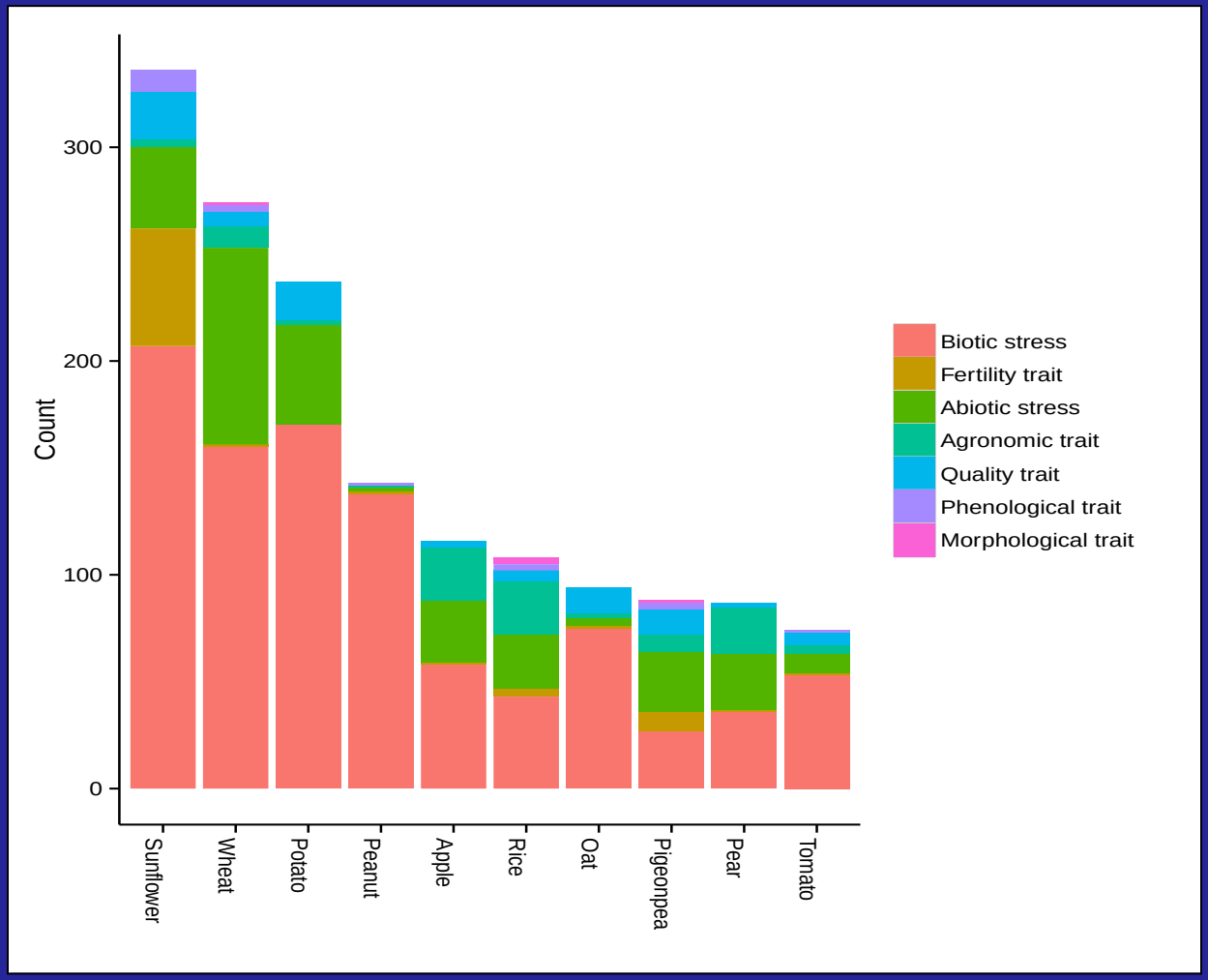
- Website to view and order seeds

https://npgsweb.ars-grin.gov/gringlobal/search.aspx?

- Phytosanitary certificates are required depending on country
- *Import permit requirements depending on country

Wild sunflowers widely used in breeding

Literature reports of use of crop wild relatives in breeding



Dempewolf et al., 2017

Wild *Helianthus* sources of resistance for diseases

Disease	Wild species		Total
	Annual	Perennial	
Rust	3	5	8
Downy mildew	10	15	25
Sclerotinia	7	18	25
Phomopsis	7	18	25
Alternaria	3	9	12
Powdery mildew	3	9	12
Rhizopus	0	4	4
Phoma	2	8	10
Charcoal rot	0	5	5
Broomrape	8	29	37
Verticillium	4	3	7

Broomrape Resistance

Helianthus **species constitute a substantial reservoir of genes conferring resistance to existing and new broomrape virulence races**

(Fernández-Martínez et al., 2000, 2010, 2012; Nikolova et al., 2000; Bervillé, 2002; Škorić 2010; Terzic et al., 2010; Antonova et al., 2011; Škorić and Pacureanu-Joita, 2011; Christov, 2013; Jan et al., 2014; Seiler and Jan, 2014; Seiler et al., 2017)

Wild annual species

Species	Race(s)
annuus	E
anomalus	E-F
argophyllus	E-H
debilis ssp. *tardiflorus*	G
debilis ssp. *debilis*	E
deserticola	E-F
exilis	E-F
petiolaris	A-H
praecox	A-G

BROOMRAPE

- Races A-E (Or_1-Or_5)

Species	Introduction	Germplasm
H. anomalus	PI 468644	ANO-1509-2
H. deserticola	PI 468701	DES-1474-1

***H. anomalus*, Utah**


H. anomalus, Utah

***H. deserticola*, Utah**

BROOMRAPE

- Race G
- Species — Source
- *H. debilis* subsp. *tardiflorus* — PI 468691


H. debilis ssp. *tardiflorus*, Florida


H. annuus, South Dakota

1980

H. argophyllus, Daytona Beach, Florida

2006

***H. petiolaris*, North Dakota**

***H. petiolaris* ssp. *fallax*, New Mexico**

***H. exilis*, Napa, California**

Broomrape
(Races E-F)

29 species of perennial sunflower have resistance

Only *H. nuttallii* had 33% incidence

Wild perennial species

Species	Race(s)
divaricatus	F-G
eggertii	F-G
grosseserratus	F
hirsutus	F
maximiliani	E-F
nuttallii	E-F
pauciflorus	E-F
resinosus	E-F
smithii	F-G
tuberosus	F-G


H. nuttallii ssp. *rydbergii*, Canada

BROOMRAPE

- Races A-E (Or_1-Or_5)

Species	Introduction	Germplasm
H. tuberosus	PI 430541	Progress
H. tuberosus	PI 430538	Novinka

***H. tuberosus*, Indiana**

BROOMRAPE

- Race F

Species	Introduction	Germplasm
H. grosseserratus	PI 617026	BR1
H. maximiliani	PI 617027	BR2
H. divaricatus	PI 617028	BR3
H. divaricatus	PI 617029	BR4

***H. grosseserratus*, Iowa**

***H. pauciflorus* (*rigidus*), North Dakota**

***H. maximiliani*, Manitoba, Canada**

***H. maximiliani*, North Dakota**


H. resinosus, Georgia

***H. smithii*, North Carolina**

***H. divaricatus*, Indiana**

***H. salicifolius*, Kansas**

C.C. Jan's Bulk Population Germplasm Releases Based on Perennial Species

Name	Germplasm	Species
SFB-CAL	Population	***H. californicus***
SFB-DIV	Population	***H. divaricatus***
SFB-DIV/GRO	Population	***H. divaricatus / grosseserratus***
SFB-GIG	Population	***H. giganteus***
SFB-GRO1	Population	***H. grosseserratus***
SFB-GRO2	Population	***H. grosseserratus***
SFB-HIR	Population	***H. hirsutus***
SFB-NUT1	Population	***H. nuttallii***
SFB-NUT2	Population	***H. nuttallii***
SFB-MAX1	Population	***H. maximiliani***
SFB-MAX2	Population	***H. maximiliani***
SFB-MAX3	Population	***H. maximiliani***
SFB-OCC	Population	***H. occidentalis***
SFB-SAL	Population	***H. salicifolius***
SFB-STR	Population	***H. strumosus***

What's ahead in the future??

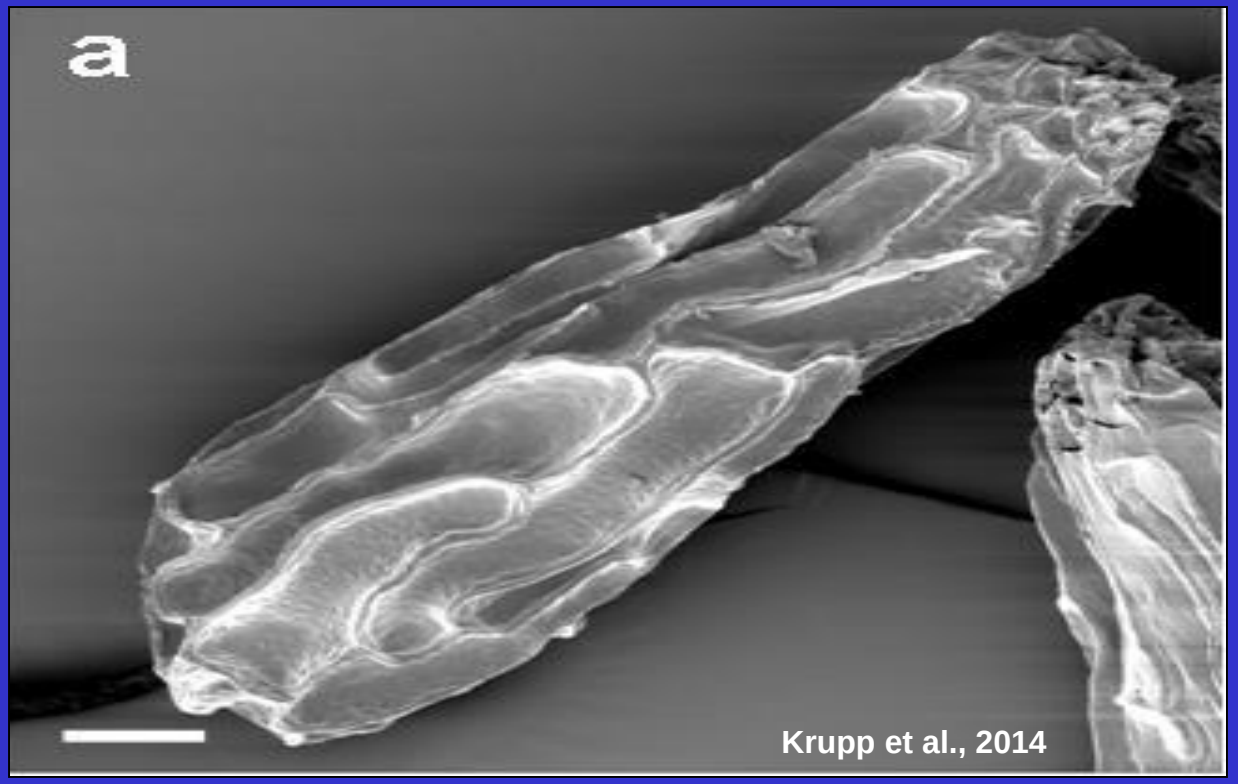


Fig. 1. Scanning electron micrographs showing the typical forms of dry seeds of *O. cumana*; Scale bar, 50 µm.

Seed=39.320 X 10^{-6} inches; 1000 seed weight =0.0029g

Future Perspective

- Genetics resources are available, but will require some effort to use
- Opportunity to move exotic genes with more precision and efficiency
- Additional molecular tools are becoming available to mine the genetic diversity
- Need a good breeding strategy for control requiring global cooperation


Thank you
Questions?