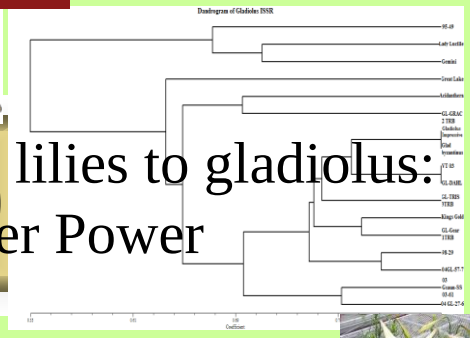
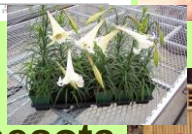
UNIVERSITY OF MINNESOTA
Driven to Discover℠



From lilies to gladiolus: Flower Power



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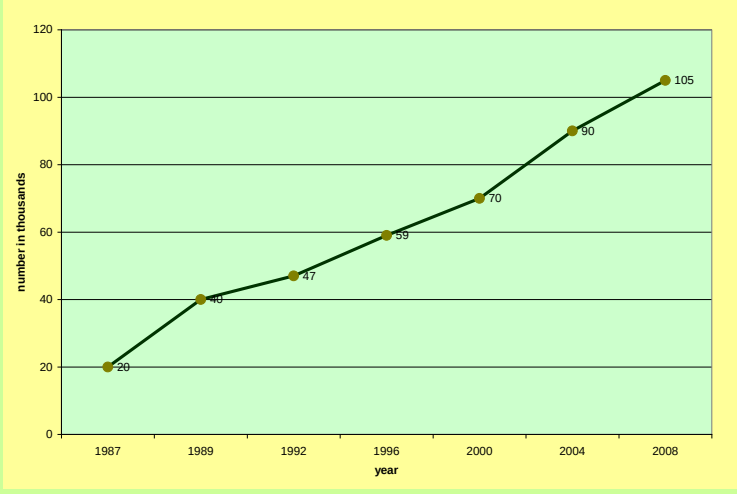
FULBRIGHT

IGERT
Graduate Training Grant for
Risk Analysis for Introduced Species & Genotypes

What drives the market: Novelty -- the number of horticultural products (cultivars) offered

(Isaacson, R. T., (ed) (1987,1989,1993,1996,2000, & 2004). Andersen horticultural library's source list of plants and seeds. 1st-6th eds. Minneapolis, Andersen Horticultural Library, University of Minnesota.
Isaacson, R. T. and K. Allen, (eds.) (2008). Plant Information Online, Andersen Horticultural Library, University of Minnesota)

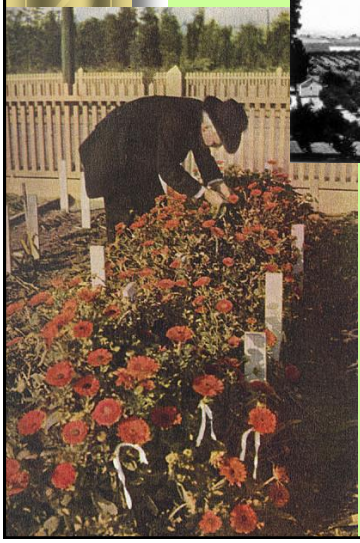


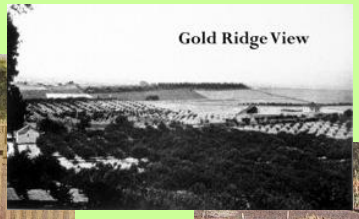
Keys to our success…

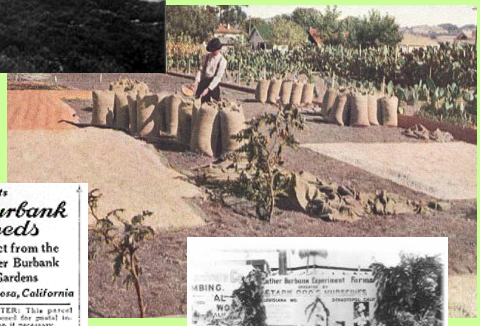
- **F_1 hybrids (petunia/impatiens)—have hybrid vigor compared to open-pollinated (OP) types**
- **Seed, veg. propagation**
- **Plastics & plug trays**
- **Automation**
- **Soilless media**
- **Post-harvest quality**
- **Shipping**

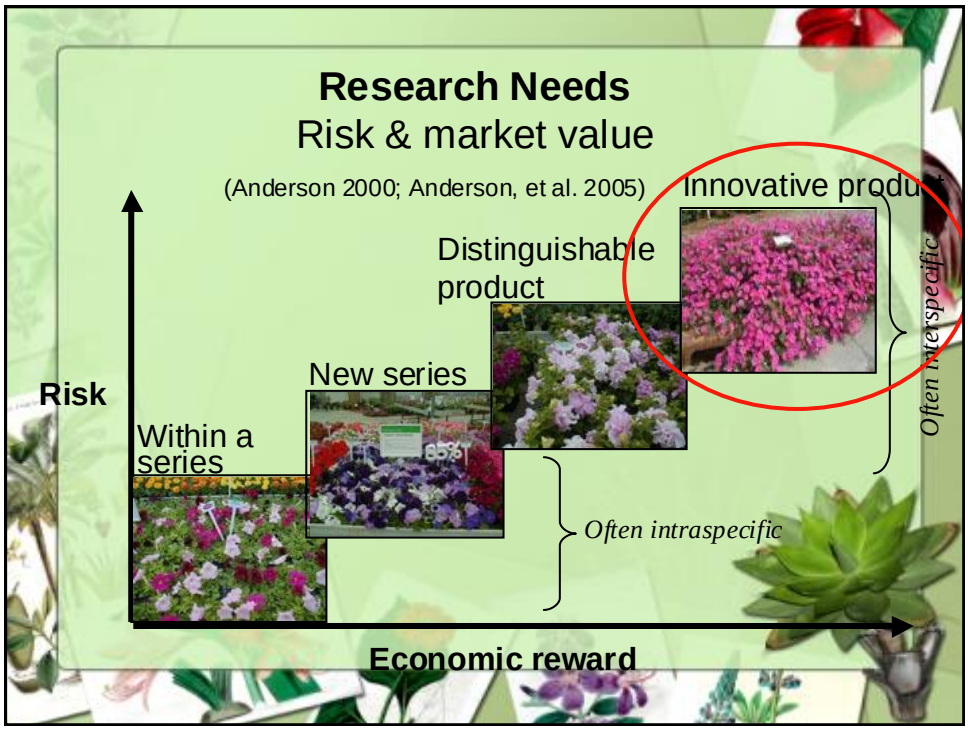
Luther Burbank – the father of US Flower Breeders

Breeding, selecting for novelty…to market!









Traits of interest to gardeners

- Co$t
- New or novel
- Instant color
- Low maintenance
- Heat/drought tolerance
- Insect/pest/disease resistance
- Edible landscapes
- Therapeutic gardening

Gen Y are looking for…

- Bytes: sound, info, garden, food, flower
- Speed, rapidity of access, impatience, good things…shouldn't take too much time (< a few seconds)
- Trending sustainable, organic, locavore, intolerant of many things (gluten, etc.)
- Floral, garden bytes: lazy, efficient gardening
- $ less of an issue than convenience (apps)
- Online shopping: Proven Winners – people pay exorbitant money for a few items + shipping online (Dirk, 2015)
- ***Flower Power & Convenience!***

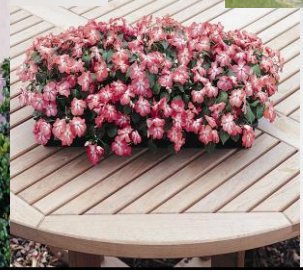
Wheelbarrow gardeners are those who hesitate to plant today for fear they will want to move the plants tomorrow

Flower Power & Convenience

- Why are bedding plants so popular?
- Flowers improve the quality of life
- Gardening is the #1 U.S. hobby (>75 million households)
- Retail expenditures for flower products were $55 billion in 2002 (USDA)
- Gardening gurus: Martha Sewart & Rebecca Coles

Flower Colors, Patterns



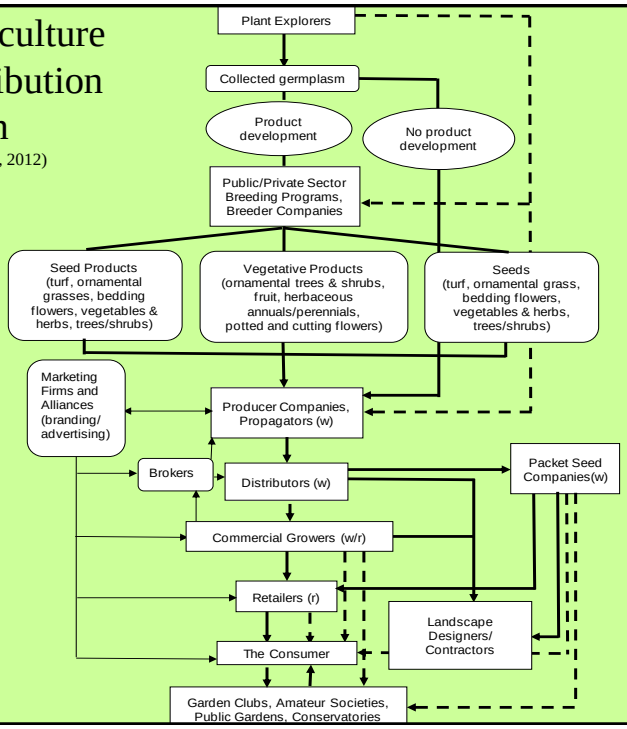




Impatiens walleriana

OP Marigold Seed Production (Gilroy, CA)

Horticulture Distribution Chain

(Drew et al., 2012)



Flower Breeding & Genetics
What are we looking for?

1926 – Winter hardy herbaceous perennials…

U of Minnesota Flower Breeding (Public Sector)

In N. America: Oldest, continuously operating public-sector flower breeding program

In the world: Oldest chrysanthemum breeding program

<u>Greenhouse chrysanthemums, roses</u>

- C.E. Cary (1924-1929)

<u>Garden chrysanthemums, (roses)</u>

- L.E. Longley (1929-1949)
- R.E. Widmer (1949-1988)
- P.D. Ascher (1988-1999)
- N.O. Anderson (1999-)

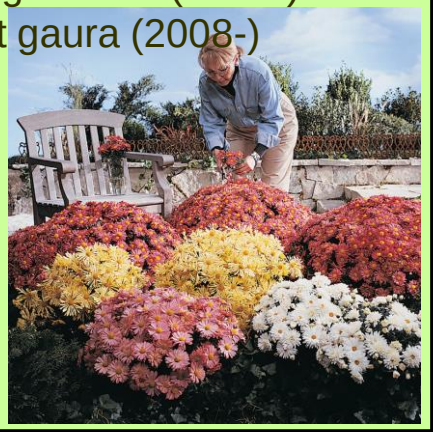
‘Beatrice’

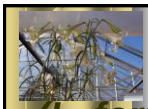
110 Cultivars Released (1939-)

- 7 - greenhouse chrysanthemums (1934-1940)
- 101 - garden chrysanthemums (1939-)
- 1 - winter hardy gladiolus (2012-)
- 1 – frost-tolerant gaura (2008-)

‘Dr. Longley’

‘Snowstorm’





Lilium xformolongi

(L. formosanum x L. longiflorum)

- Flower ~200+d >sowing
- Continuous flowering
- SC; sig. inbreeding depression
- *VER1, VER2* genes for non-vernalization requirement
- Long-term breeding objective: seed-propagated, colored hybrids with continuous flowering

(Anderson, et al., 2012a, b; Anderson and Dunn, 2003; Anderson, 2005, 2007; Zlesak and Anderson, 2010)

(Zlesak and Anderson, 2010)

Early Objectives (2000-2010)

- **Introduction of color into *L. xformolongi* types (Sec. Leucolirion) via interspecific hybridization**
- **Potential methods to overcome issue of vernalization req't. & long juvenility:**

1. ***L. martagon* – Class I (Baranova, 1972) initiates flowers < cold, although distantly related (Sec. Martagon)**
2. ***L. rubellum* -- interspecific hybrid bridge cultivars, e.g. 'Rosario'; closely related**
3. ***L. longiflorum* – pk. colored forms**

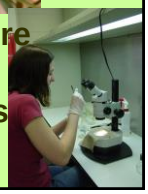
Genotypes, Crosses, ER

- ***L. xformolongi*** **parents: several tested, most successful genotype w/ GCA—[00L-111-343 x 51-202-1] BC_1**
- ***L. martagon*** ***GCA*** **parents: 'Arabian Knight', 'Cadense', 'Claude Shride', 'Mrs. R.O. Backhouse', 'Nepera', 'Slate's Select', 'Terrace City'** (Frans Officer)



- **Crossed in both directions using cut style technique** (Lim and van Tuyl, 2006)

- **ER required in all cases when female parents were *L. martagon* (14d post-pollination)**
- **ER required (34-50d, late term) for majority of F_2s**

Most successful cross (07L-14) for colored interspecifics


L. formosanum x *L. longiflorum* — *L. formosanum* x *L. longiflorum*

L. xformolongi 'Raizan Herald' LD(4) x *L. xformolongi* 'Raizan' #1 LD(3)

00L-111-34 selfed — *L. formosanum* 92-252B-3 selfed

00L-111-34-3 F_2 x 51-202-1 F_2

[00L-111-343 x 51-202-1] BC_1 x *L. martagon* 'Cadense'

(n=111

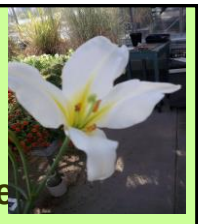
F_1s)

ISSRs of 07L-14 Interspecific lily (parents, F_1 hybrids)

L. xformolongi x L. martagon

(Anderson, et al., 2009; 2011)

Goals for recombinant lilies



- **Determine h^2, allelic expression of unique 07L-14, 06L-11 recombinant morphological traits (BCs, CBCs)**
- **Assay unique recombinants for similarity with:**
  - ***lam-1* mutant *(Nicotiana sylvestris*)**
  - ***narrow leaf1 (nal1)* mutant *(Oryza sativa)* – same leaf morphology**

<u>Comparative recombinant vs. WT assays of plants, leaves:</u> macro-/microscopic histology, SEM, obtain *lam-1* sequence, probe recombinants for sequence homology and gene sequences for similarity with related monocots; mapping mutant gene, dev. of mapping population, PCR markers

(McHale, 1992; Qi, et al., 2008)

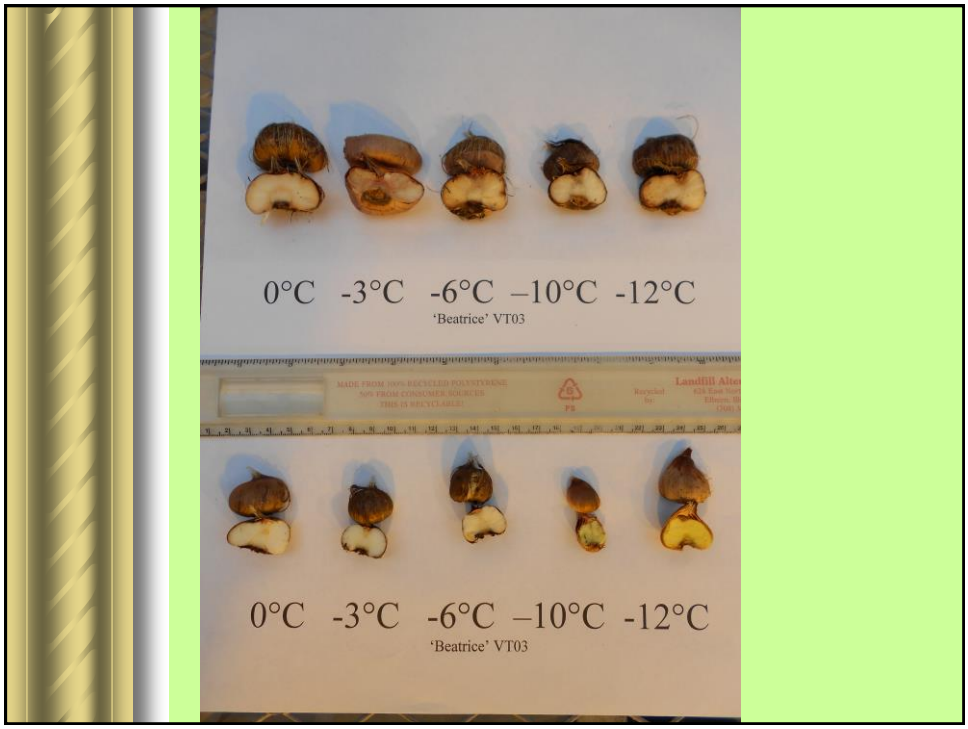
Winter hardy *Gladiolus*

- Who wants to dig corms every fall?
- 'Beatrice' (Z4; Z3 if mulched)
- In trials with potential licensees
- Establishing N.A. production chain for this geophyte

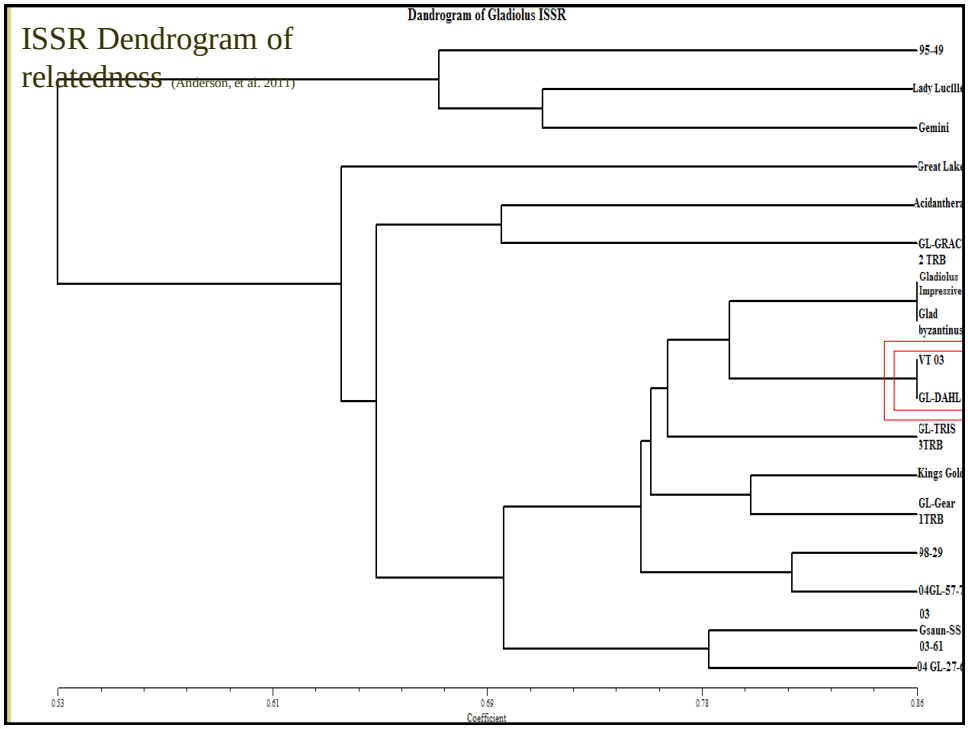
Year 3 plant

'Beatrice' Lab Freezing Tests: scores for corm tissues (1-5 scale)

Temp.	Basal Plate	Stem, Main axis	Apical Meristem	Corm tissues
0C	5	5	5	5
-3C	4.5	5	4.5	5
-6C	4.5	5	3.5	4.5
-10C	4	4	3.5	4.5
-12C	3.5 (LT_{50})	4	3.5 (LT_{50})	4.5



ISSR Dendrogram of relatedness (Anderson, et al. 2011)



Hardiness Heritability (h^2)

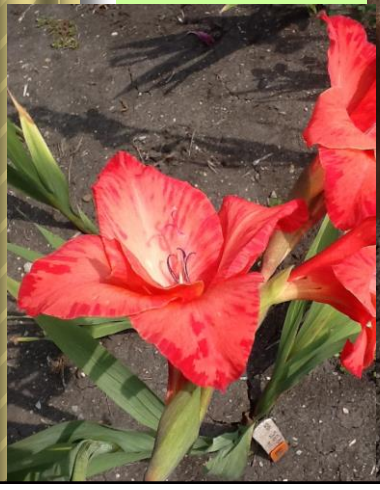
Crossing Group	No. Roots	Root Length	Corm damage	Shoot Length
Hardy x hardy	0.08	0.29	-0.04	-0.43
Hardy x Non-hardy	0.31	0.37	0.08	0.19
Non-hardy x Non-hardy	0.67	-0.14	0.15	-0.15

(Anderson, et al. (2011). Heritability of cold tolerance (winter hardiness) in *Gladilus xgrandiflorus*. InTech, Plant Breeding.)

What we're looking for…

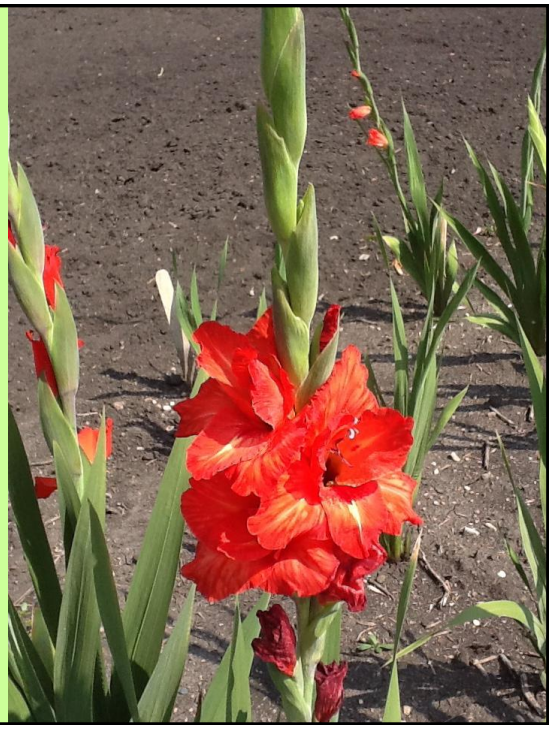
- **Winter survival**
- **-AND-**
- **Yearly flowering without digging**
- **Multi-corm survival for multiple flowering clumps**

Y-not Wild colors & combinations?



Decrease internode lengths in flowers
&
add in flower surround

This created a completely new form…



Dwarf, potted gladiolus? Example interspecific hybrid changes

- Dwarf plants, large flower types
- Flower surround vs. "faced"

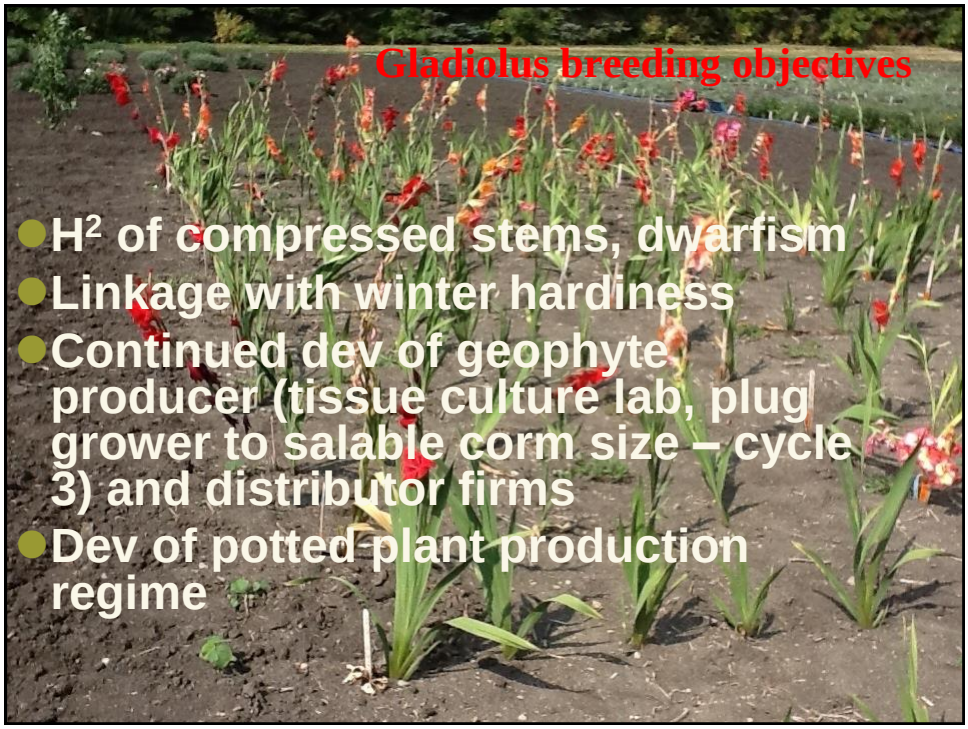
Rapid generation cycling

- **Normally: 3-5 years (sowing to flowering)**
- **Selection strategies to reduce generation time:**
  - **Germination (G) wk (plug phase; toothpicking)**
  - **Correlate G with flowering date**
  - **Fast cycling of "generations": combining truncated periods of greenhouse growth, dry down & cold storage treatments**
  - **Selection for high leaf number and early stem stalk emergence in cycles 1-3**

  - **Tested with 71 crosses (N=1,026 seedlings):**
  - **G primarily in G2-G4 (some in G5-G7)**
  - **Cycle 1: 100% - 1 lf/seedling**
  - **Cycle 2: 1-7 lvs/seedling; 6% had elongated stems (1-4 lvs)**
  - **Stem elongation is highly heritable trait (6 crosses)**
  - **Cycle 3: flowering in high leaf no. & seedlings w/stems (Cycle 2)**

3 generations/year possible, combining truncated periods of greenhouse growth, dry down & cold storage treatments

(Anderson, et al., 2015)



Funding sources—Thank you!

- MN Agric. Expt. Station
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- Ball Horticultural Company
- Beatrice H. Anderson Flower Breeding Fund
- J. William Fulbright (CIES)
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