# Low Phytate Soybeans:
## *Can we solve the germ problem?*

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# *Low Phytate Soybean Germplasm*

| Mutations | Germplasm | Phytate content* | Germplasm Citation |
| --- | --- | --- | --- |
| *Lpa1* & *Lpa2* | Cx1834 | 37% normal | Wilcox et al. (2000) |
| *MIPS1* | V99-5089<br>Lr33<br>*GM-Lpa*-TW1 | 67% normal | Saghai Maroof & Buss (2008)<br>Hitz et al. (2002)<br>Yuan et al. (2007) |

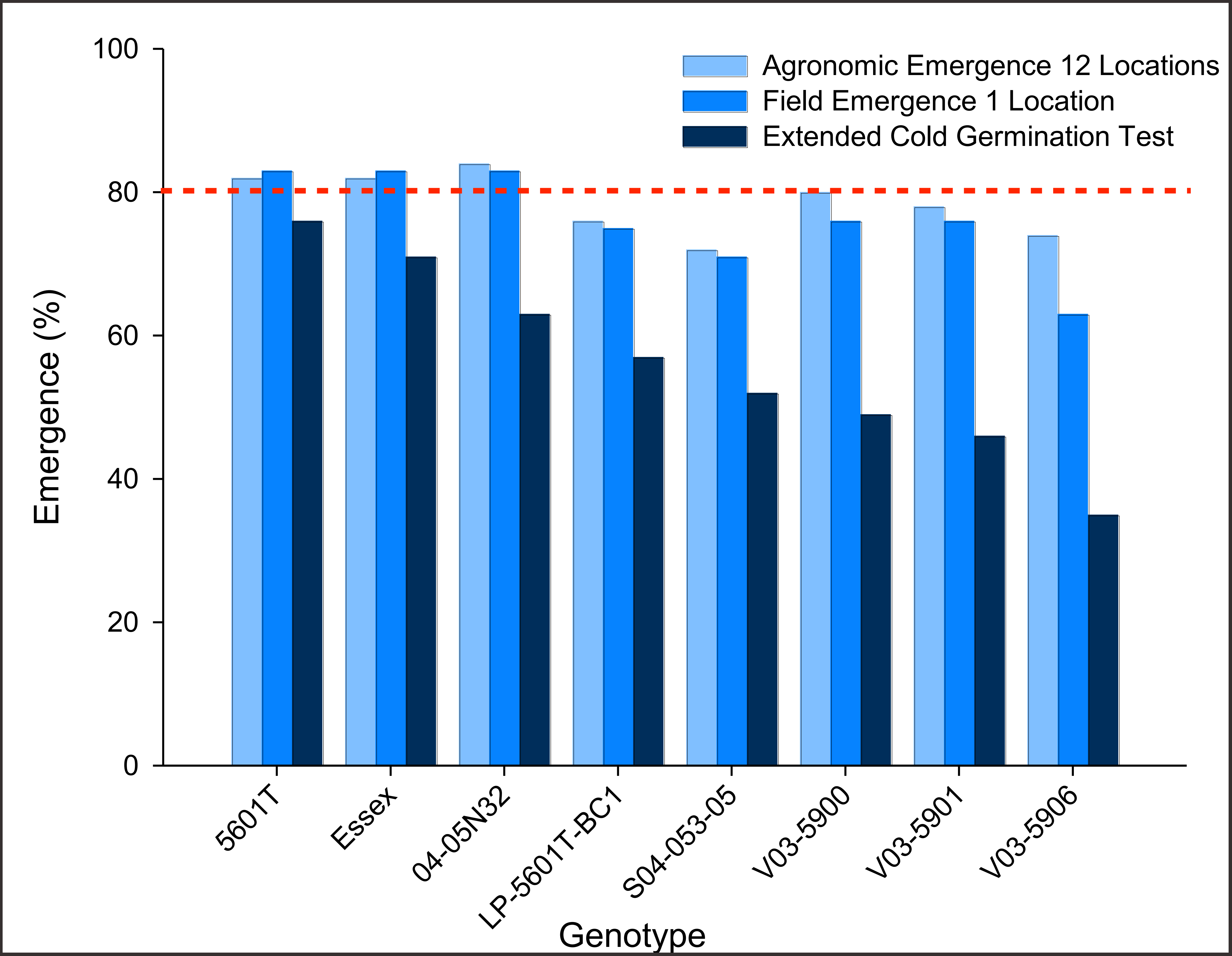
** Summarized from Maupin (2010)*

# 12 Environment Study: Experiment

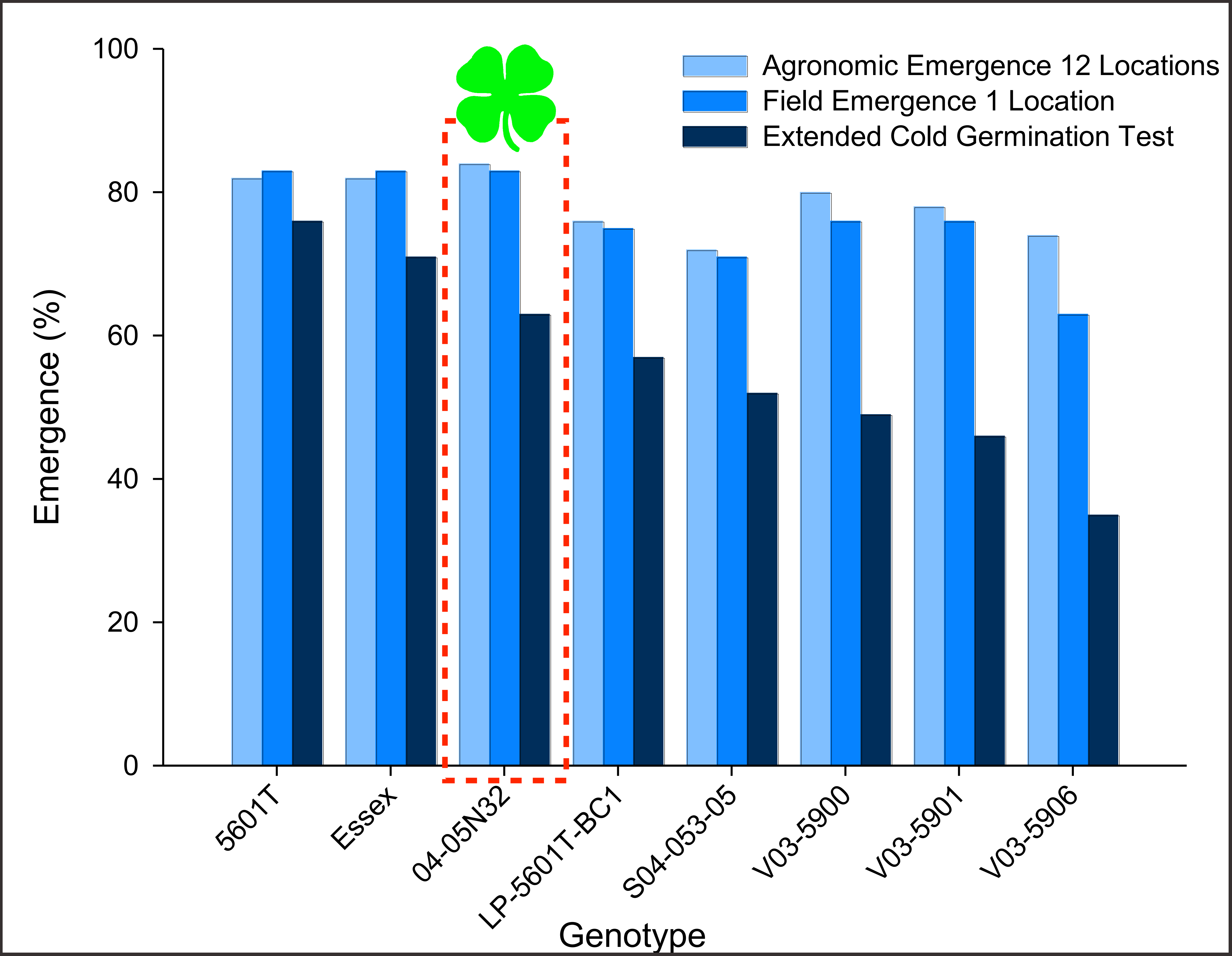
- Germplasm
  - 3 *Lpa* mutants
  - 3 *MIPS1* mutants
  - 2 WT
- 12 Environments
  - 2 years x 6 locations
    Queenstown, MD, Portageville, MO, Plymouth, NC, Knoxville, TN, Blacksburg, VA, and Mount Holly, VA in 2008 and 2009.
- Data
  - P content: Pi, HPIC, and new colorimetric phytate
  - Germination & Emergence
    - stand counts
    - extended cold germination test (ECGT)
    - warm germination
    - Field emergence: seed from 12 env planted into 1 env

*Trimble & Fehr, 2010*

*Maupin 2010*




*Maupin and Rainey, 2011*




*Maupin and Rainey, 2011*

# 12 Environment Study: Emergence Results

| | Standard Germination | 2009 Agronomic Emergence | | | | | | Standard Germination | 2010 Agronomic Emergence | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotype | VAMH 2008 Seed | NC | MD | VAMH | TN | VABB | MO | VAMH 2009 Seed | MD | NC | VABB | TN | MO | VAMH | Mean§ |
| 5601T | 92 | 98 | 96 | 83 | 88 | 90 | 47 | 98 | 95 | 87 | 85 | 75 | 79 | 56 | 82ab |
| Essex | 84 | 95 | 95 | 88 | 82 | 89 | 53 | 97 | 93 | 86 | 82 | 74 | 76 | 69 | 82ab |
| 04-05N32 | 94 | 97 | 93 | 89 | 91 | 88 | 69 | 98 | 96 | 85 | 76 | 75 | 78 | 67 | 84a |
| LP-5601T-BC1 | 83 | 95 | 91 | 91 | 85 | 70 | 50 | 95 | 88 | 82 | 69 | 68 | 56 | 66 | 76cde |
| S04-053-05 | 88 | 95 | 71 | 86 | 80 | 58 | 42 | 96 | 94 | 82 | 72 | 77 | 65 | 46 | 72e |
| V03-5900 | 83 | 96 | 96 | 89 | 87 | 86 | 39 | 97 | 97 | 83 | 80 | 72 | 75 | 56 | 80abc |
| V03-5901 | 87 | 97 | 93 | 79 | 84 | 87 | 32 | 98 | 97 | 85 | 75 | 75 | 71 | 68 | 78bcd |
| V03-5906 | 84 | 95 | 91 | 80 | 83 | 80 | 30 | 97 | 95 | 76 | 71 | 66 | 72 | 51 | 74de |
| Mean§ | | 96a | 91abc | 85bcd | 85bcd | 81cde | 45g | | 94ab | 83cd | 76de | 73e | 71e | 60f | |
| Correlation | | | | | | | | | | | | | | | |
| Standard Germination | | | | | | | | | | | | | | | |
| *r* | | 0.74 | -0.05 | -0.11 | 0.56 | 0.22 | 0.54 | | 0.82 | 0.43 | 0.61 | 0.42 | 0.89 | 0.20 | |
| *P* | | * | ns | ns | ns | ns | ns | | ** | ns | ns | ns | ** | ns | |
| Extended Cold Germination Test | | | | | | | | | | | | | | | |
| *r* | | 0.34 | 0.16 | 0.56 | 0.36 | 0.20 | 0.80 | | 0.21 | 0.63 | 0.66 | 0.77 | 0.33 | -0.18 | |
| *P* | | ns | ns | ns | ns | ns | * | | ns | ns | ns | * | ns | ns | |
| Field Emergence Test | | | | | | | | | | | | | | | |
| *r* | | 0.53 | 0.45 | 0.40 | 0.49 | 0.57 | 0.57 | | 0.09 | 0.74 | 0.69 | 0.40 | 0.27 | 0.39 | |
| *P* | | ns | ns | ns | ns | ns | ns | | ns | * | ns | ns | ns | ns | |

# 12 Environment Study: Other Notable Results

- Low phytate trait *per se* not associated with poor agronomic performance
- Significant differences for P content among *Lpa* mutant lines
- Differential stability for P content
- Low overall P = good emergence

# *Low phytate soybeans can have poor germination and emergence.*

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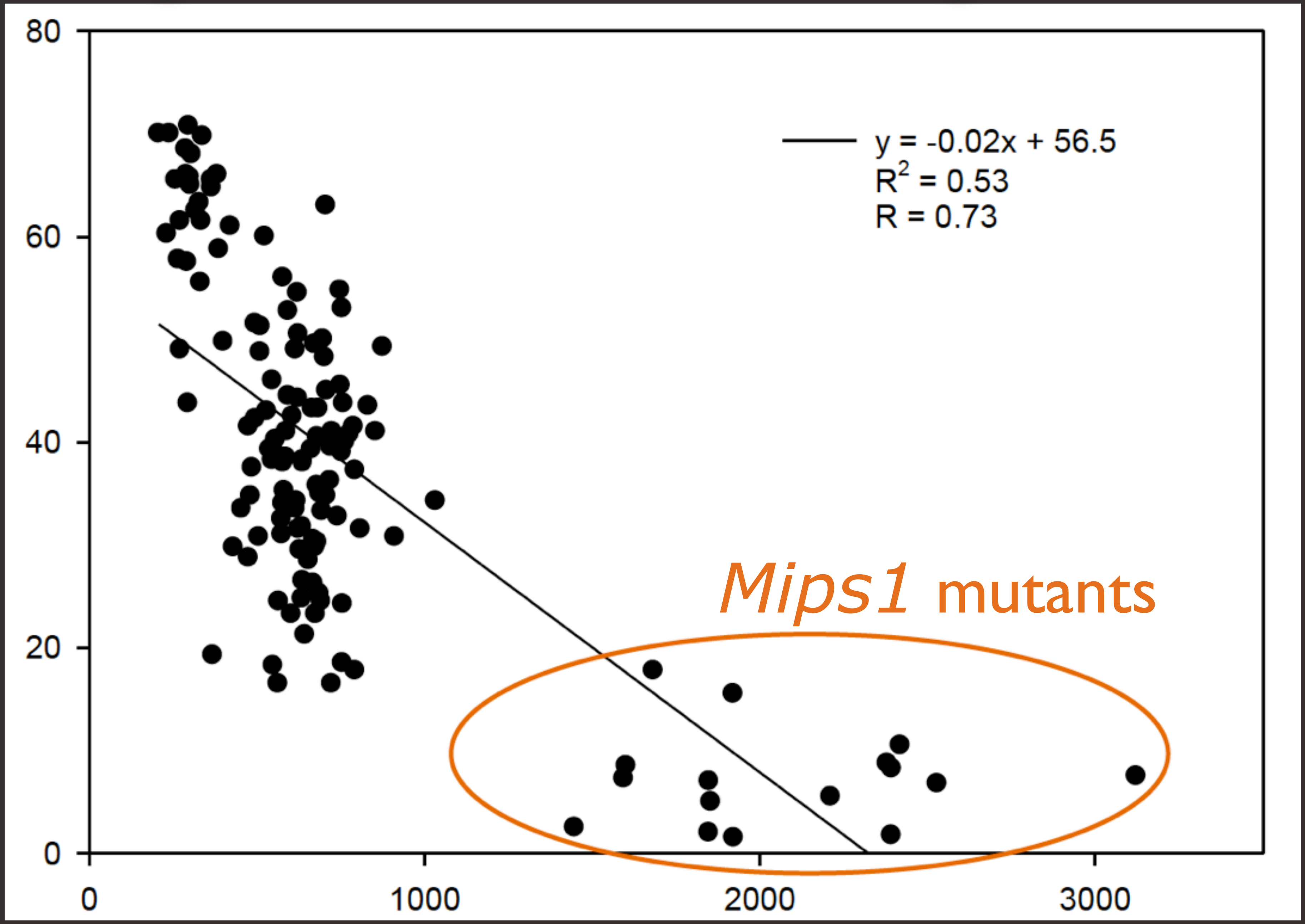



$F_{2:4}$ % Emergence

$F_2$ Inorganic Phosphorus (ug g-1)

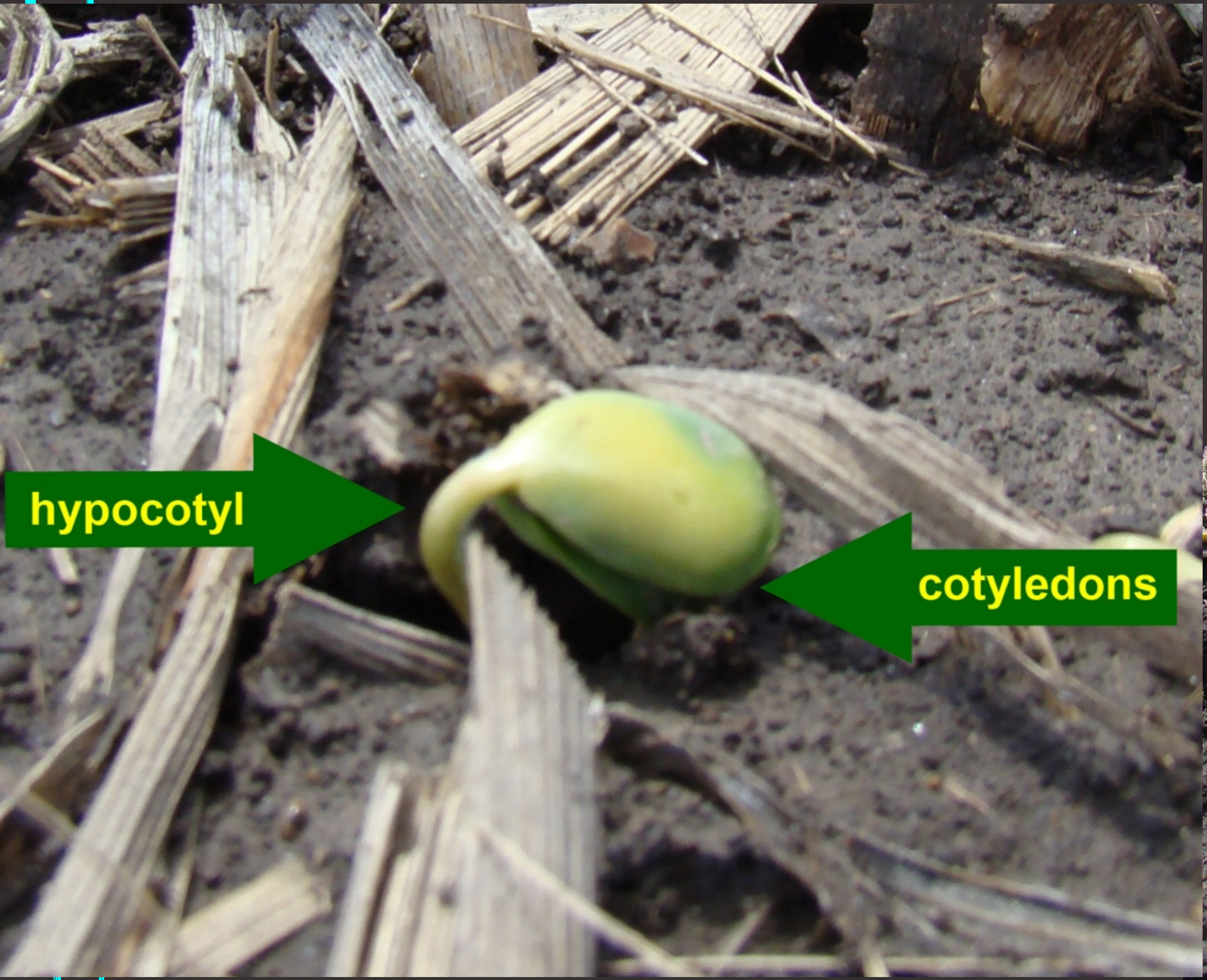
*Maupin (2010)*

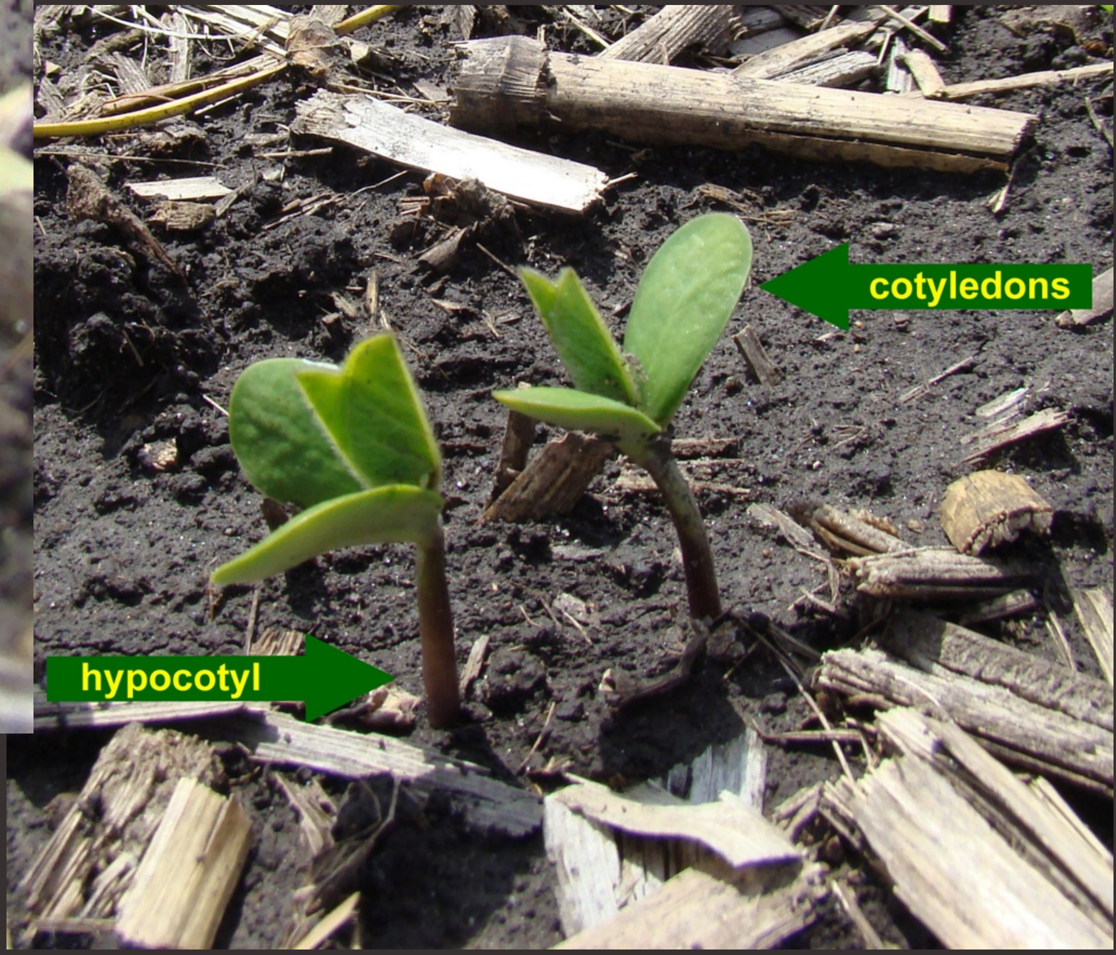
*Low phytate soybeans can have poor germination and emergence.*

CX1834-derived:

Hulke et al. (2004)
Oltmans et al. (2005)
Spear and Fehr (2007)
Scaboo et al. (2009)

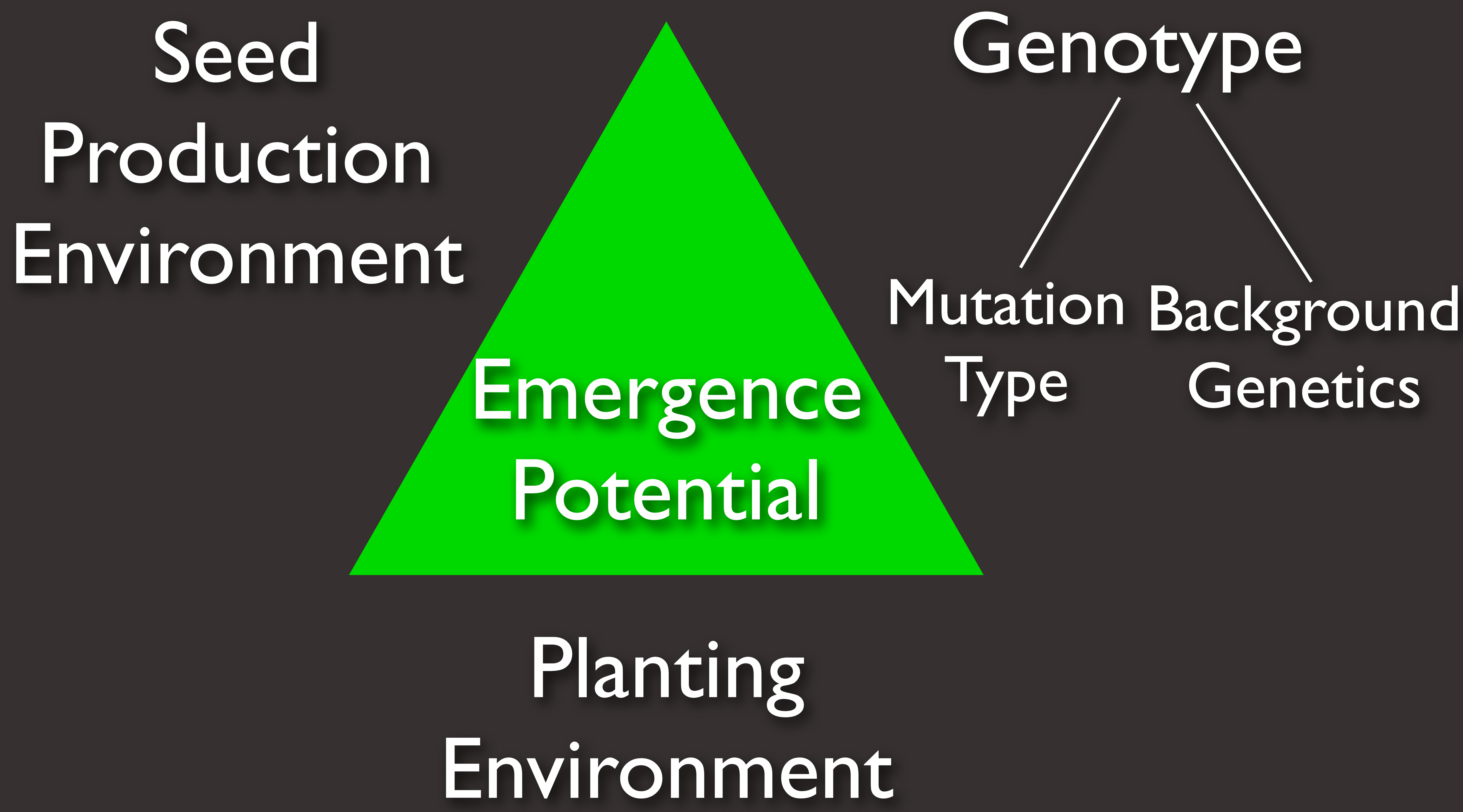
# *Germination is Not Field Emergence*



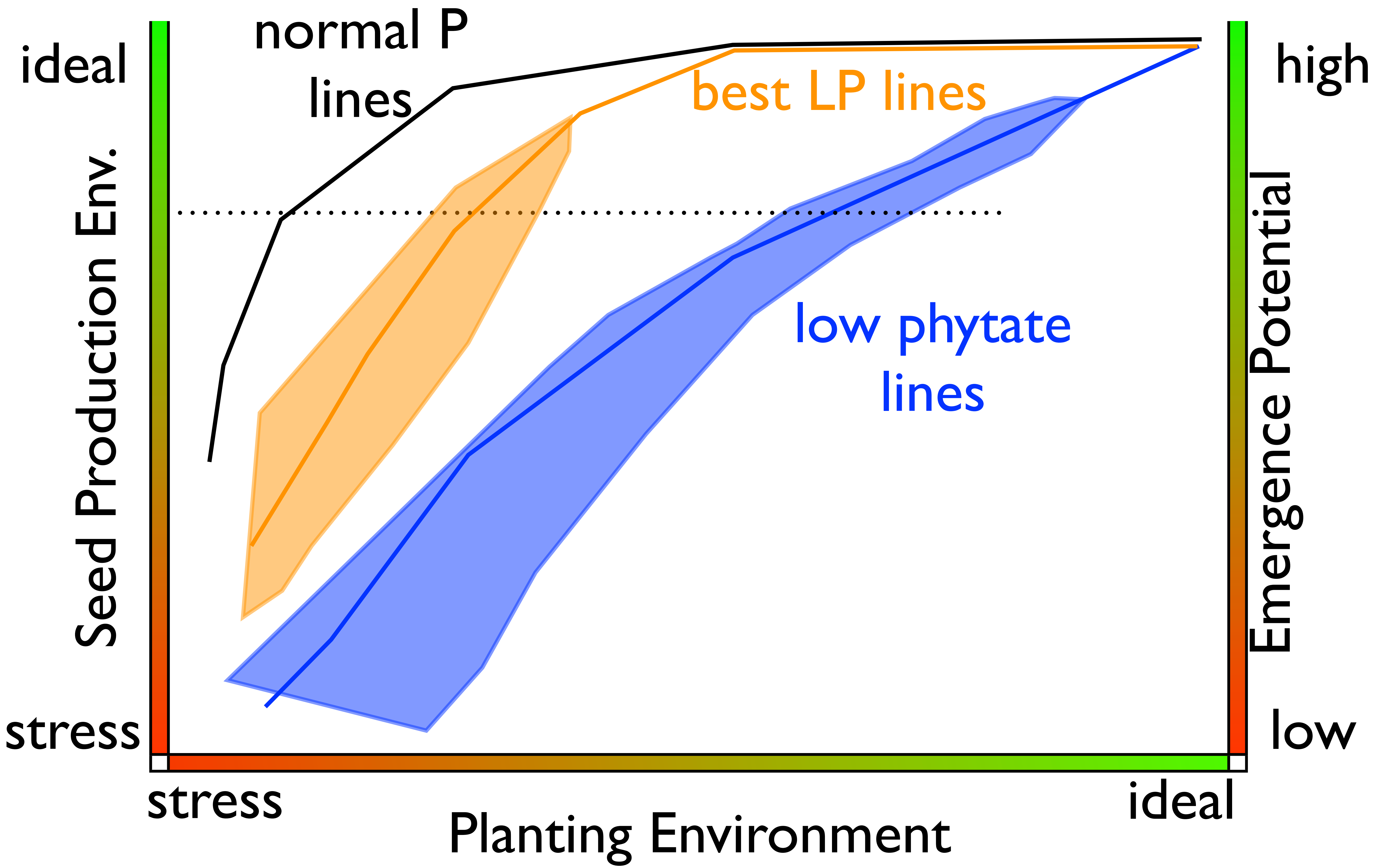




*http://extension.entm.purdue.edu/pestcrop/2010/issue7/index.html*

# *Emergence is a Dynamic Trait*



# *Emergence Model*



Theor Appl Genet (2009) 118:1211–1221
DOI 10.1007/s00122-009-0975-8

ORIGINAL PAPER

# Isolation and characterisation of an *lpa* (low phytic acid) mutant in common bean (*Phaseolus vulgaris* L.)

**Bruno Campion · Francesca Sparvoli · Enrico Doria · Giovanni Tagliabue · Incoronata Galasso · Marzia Fileppi · Roberto Bollini · Erik Nielsen**

*Common assumptions about germination and emergence in low phytate soybeans.*

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linkage

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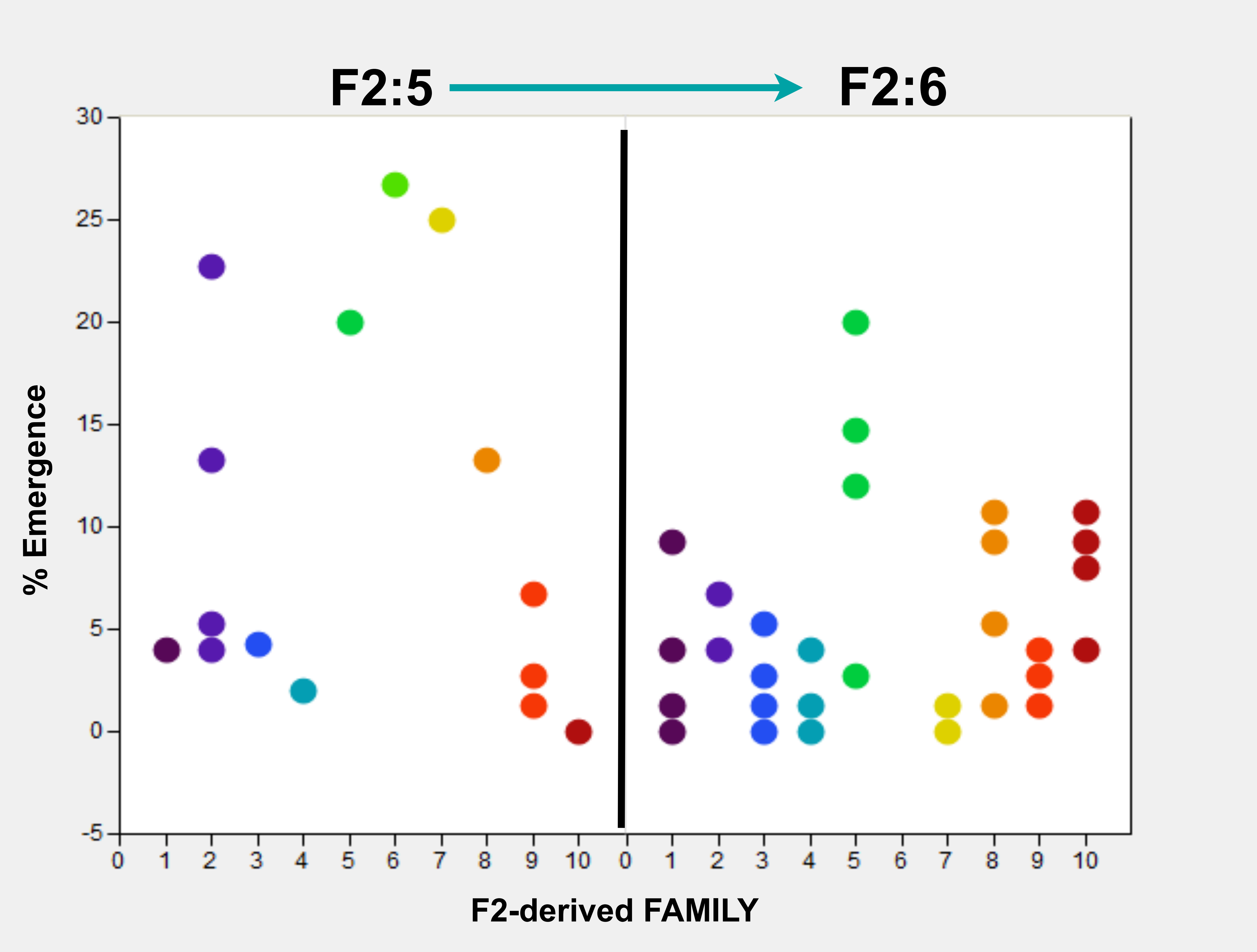
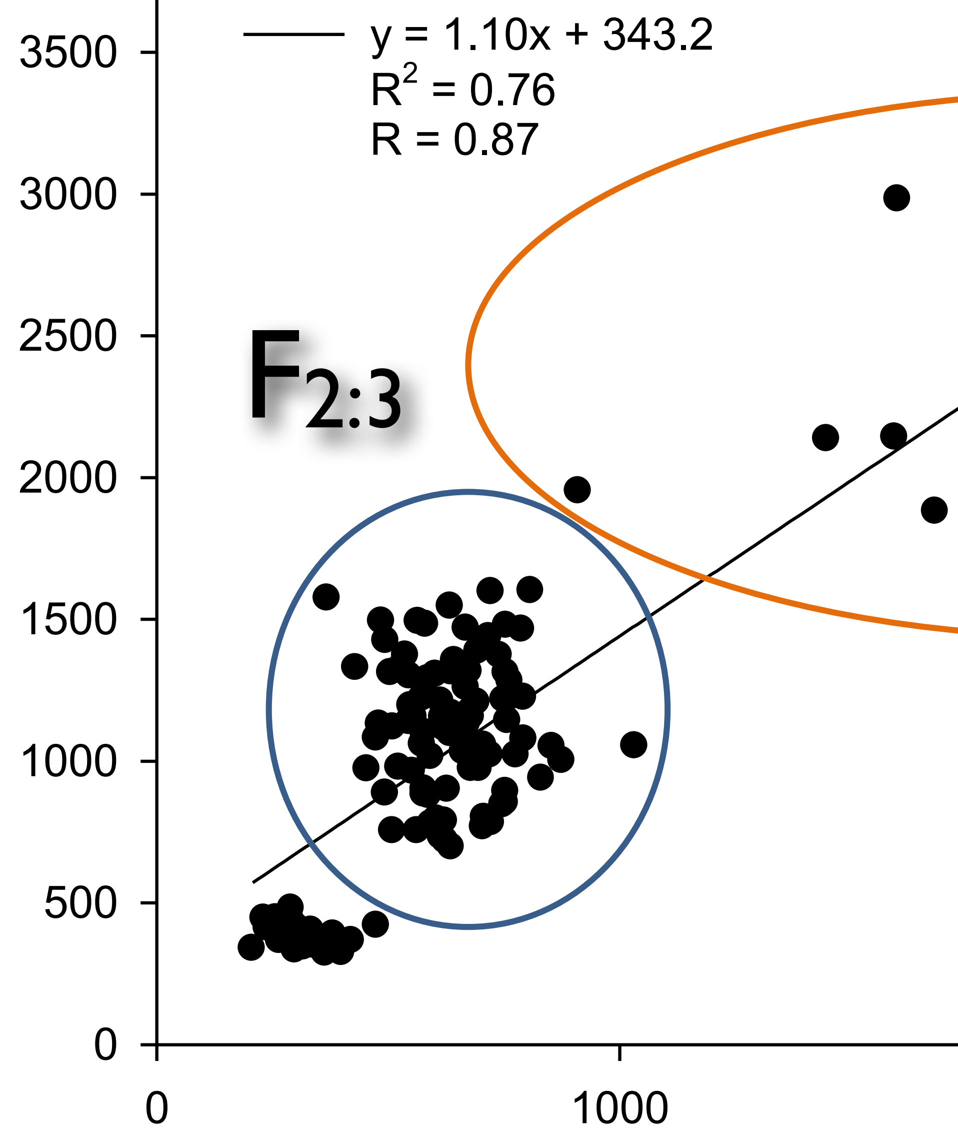
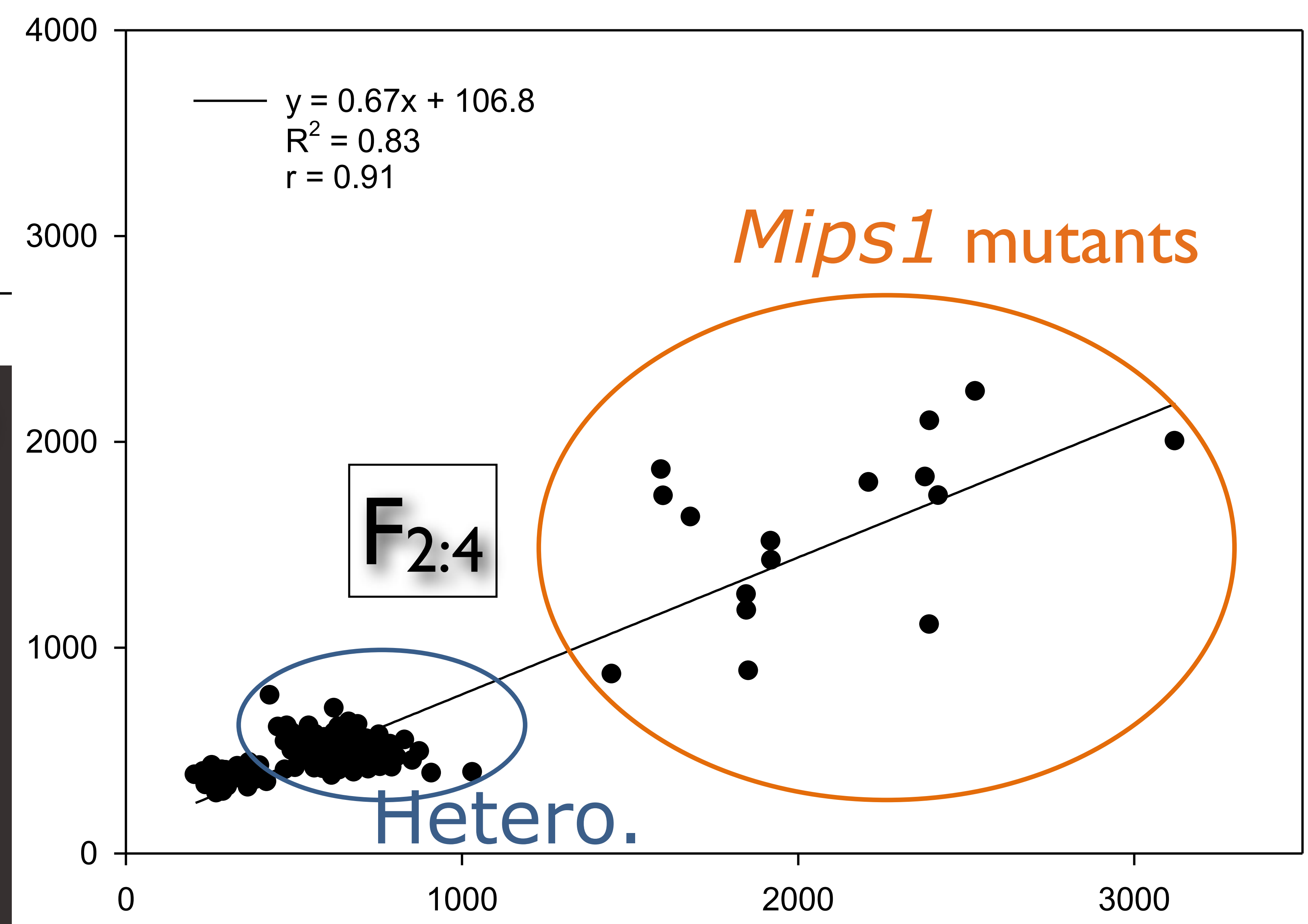
# natural selection?



# Shifting Allele Frequency

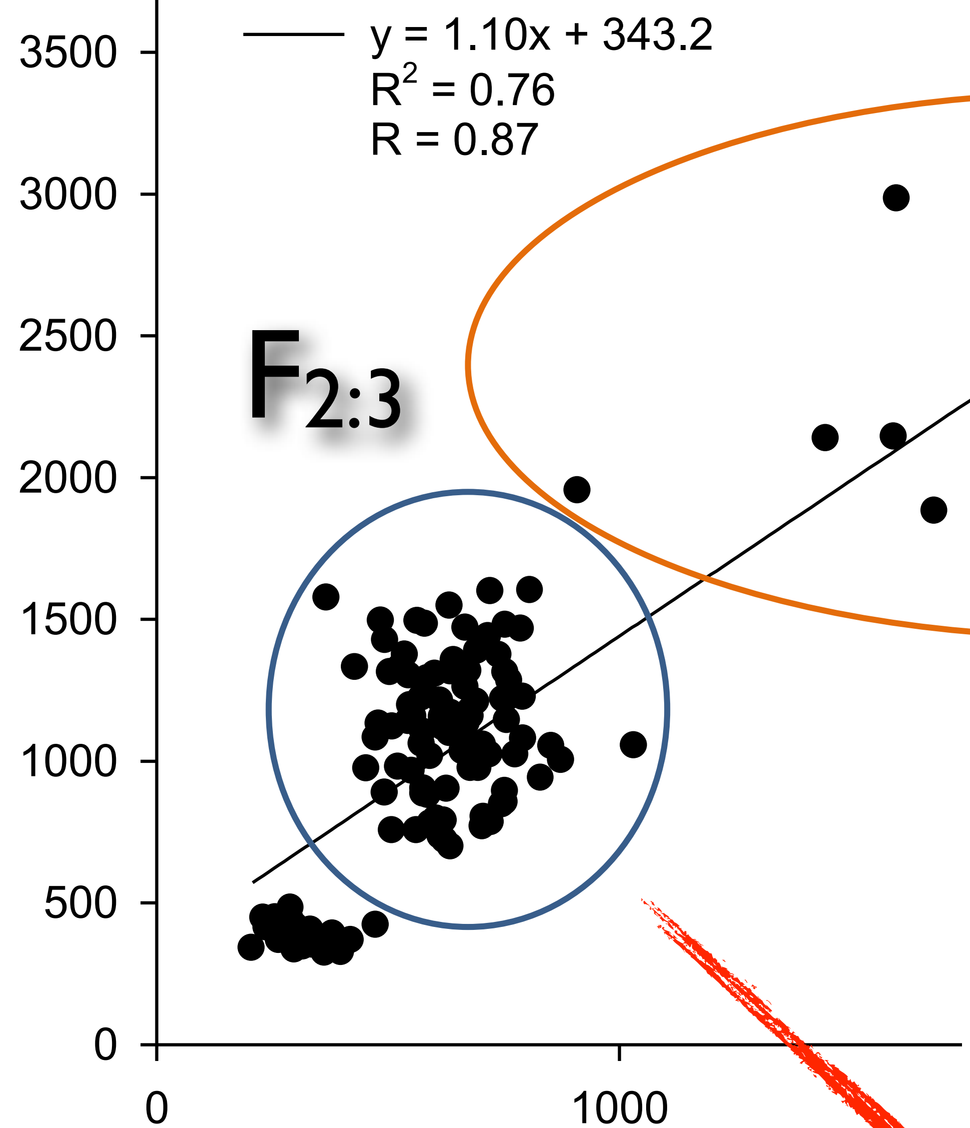



*Maupin (2010)*

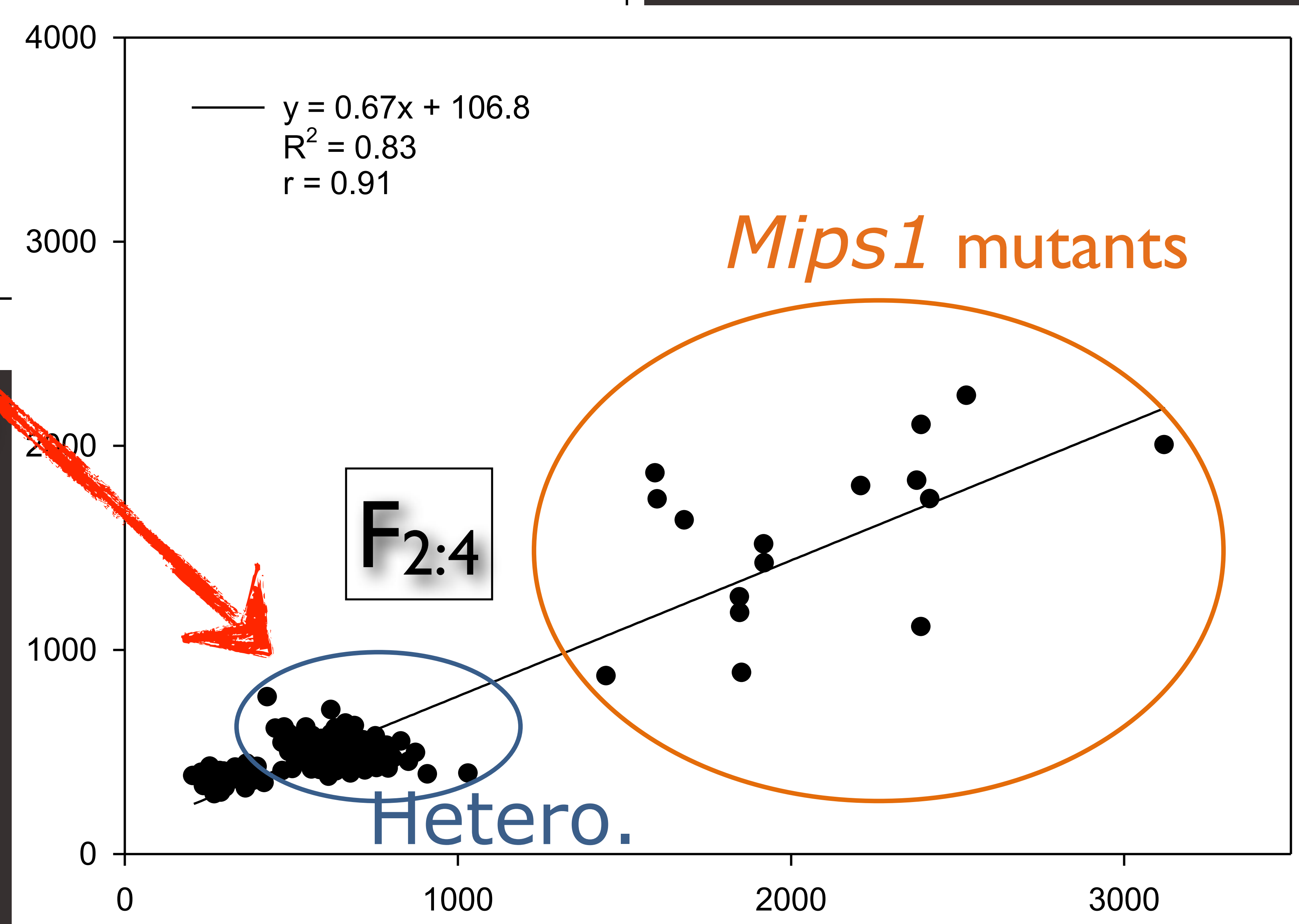



$F_2$ Inorganic Phosphorus ($ug\ g^{-1}$)

# Shifting Allele Frequency



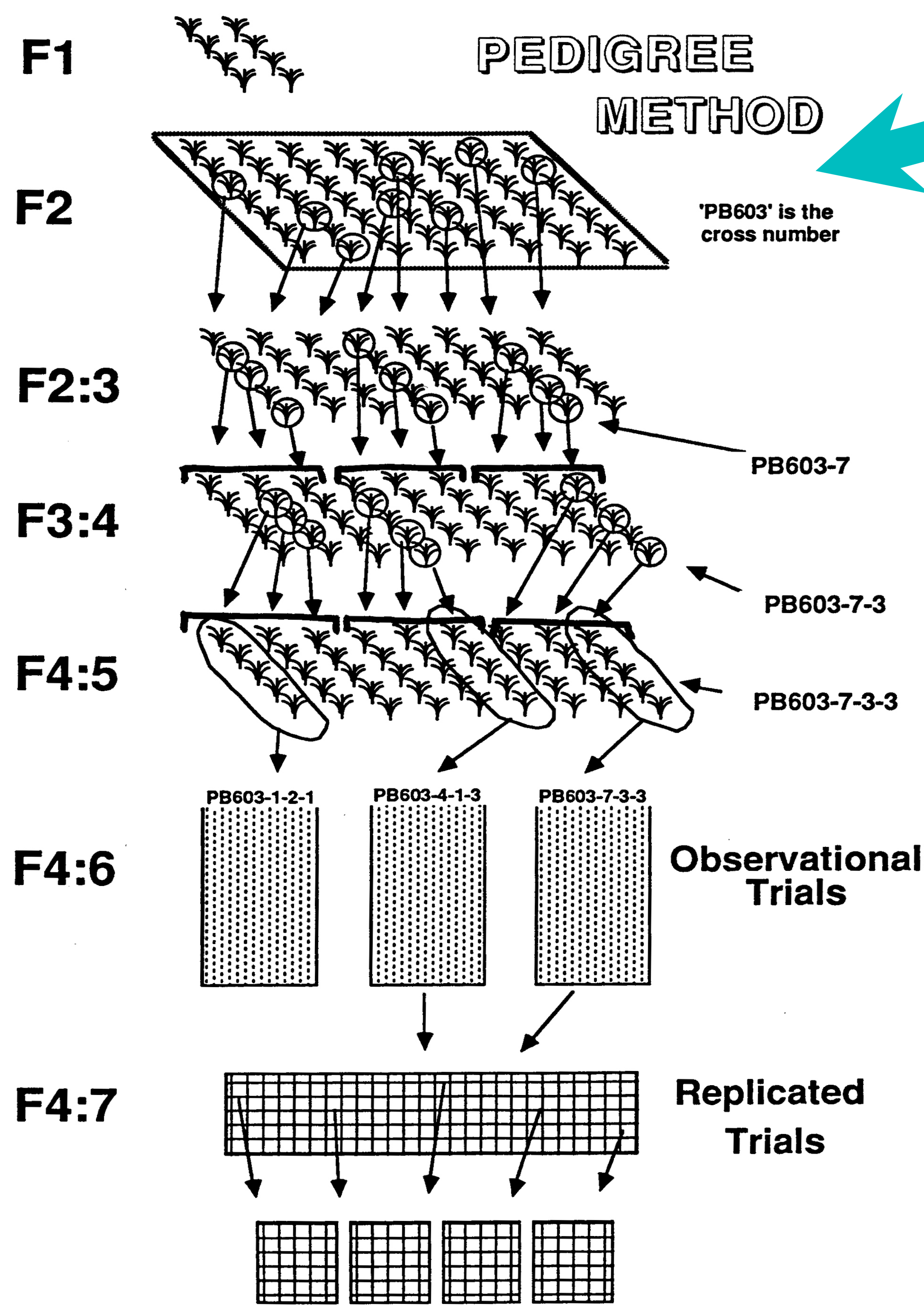

*Maupin (2010)*



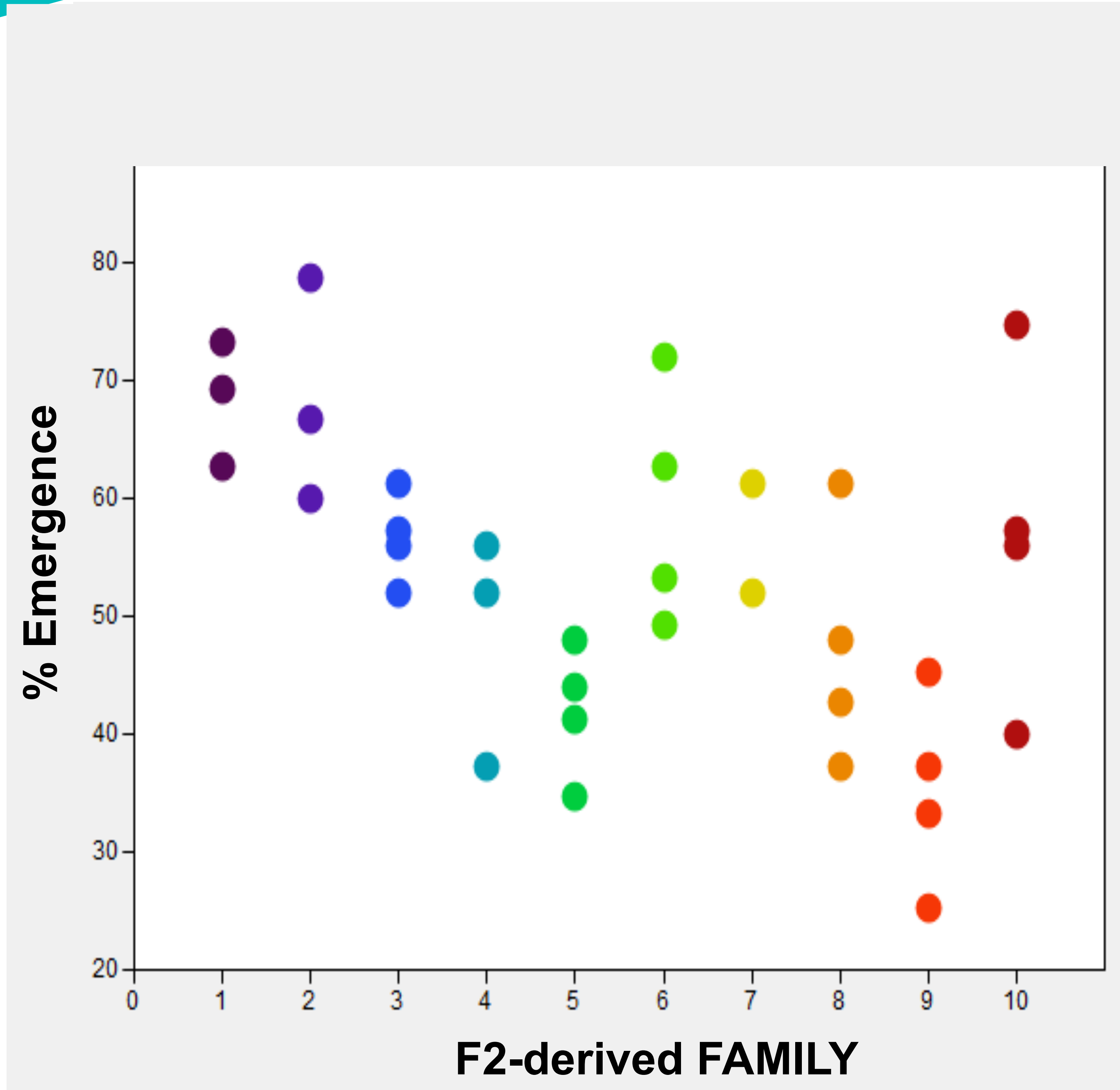

$F_2$ Inorganic Phosphorus (*u*g $g^{-1}$)

# Pedigree Method: Genotypic Selection

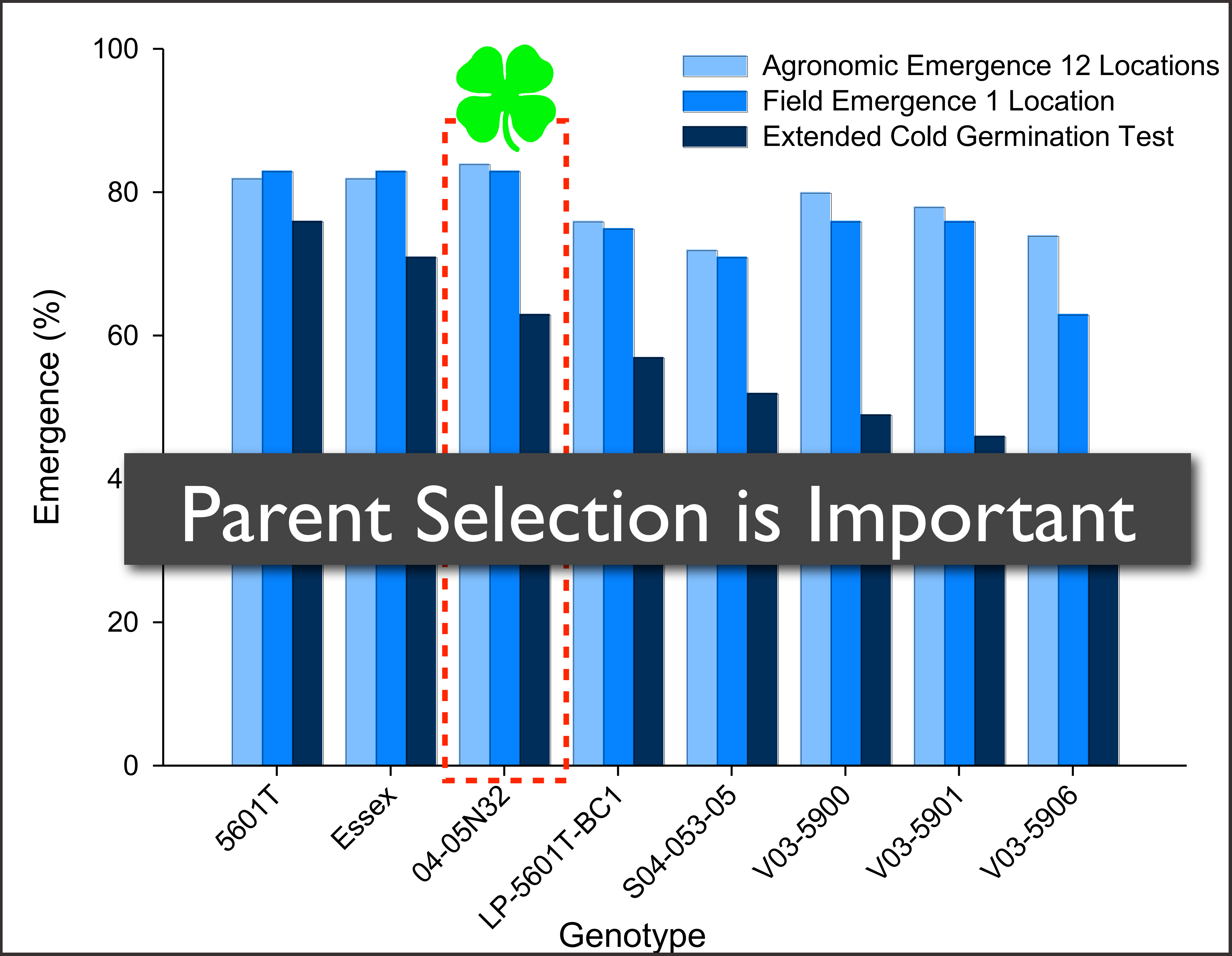
*"if it quacks 3 times its a duck"*




**Need large $F_2$**



# Parent Selection is Important

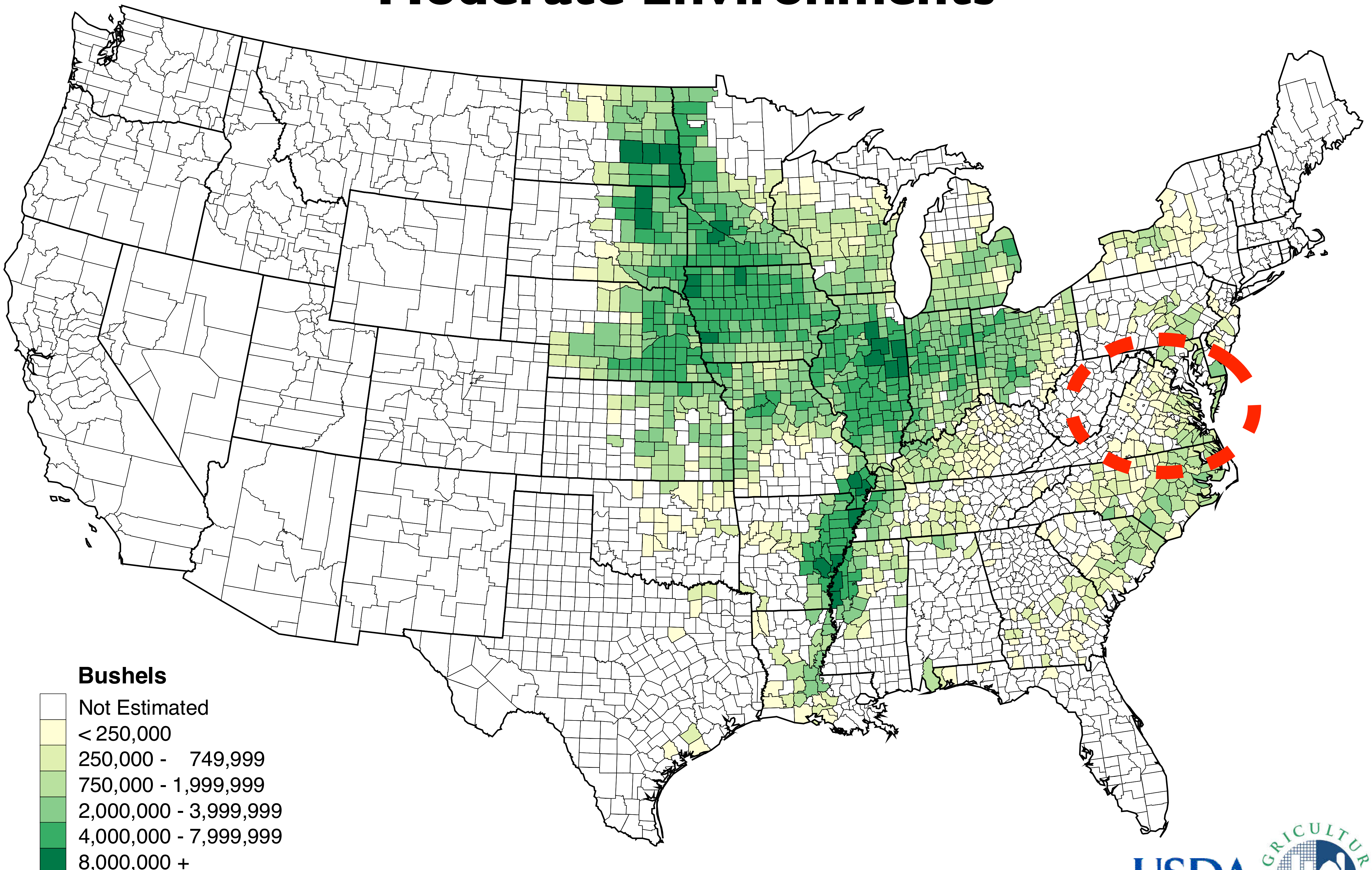



*Maupin and Rainey, 2010*

# Parent Selection is Important

| | | | 2010 GERM TESTING | | |
|---|---|---|---|---|---|
| NAME | Phenotype | MG | FIELD EMERGENCE | GERM ASSAY | ACCELERATED AGING |
| V07-6412 | LP/ *MIPS1 mutant* | M5 | 80 | 32 | 7 |
| VS07-1779 | LP/ *MIPS1 mutant* | L4-E5 | 77 | 89 | 24 |
| VS07-1265 | LP/ *MIPS1 mutant* | 2-E3 | 27 | 67 | 30 |
| VS07-1314 | LP/ *MIPS1 mutant* | M5 | 85 | . | 42 |
| SSRT 3860 | normal P | 3 | 73 | 66 | 62 |
| PI 588026A | normal P | 4 | 71 | 83 | 66 |
| 0405N32 | LP/*Lpa* mutant | 6 | 76 | 57 | 67 |
| V03-4660 | normal P | L4-E5 | . | 85 | 79 |
| PI 588030 | normal P | 4 | 68 | 89 | 86 |
| Glenn | normal P | M5 | 82 | 96 | 90 |
| 5002T | normal P | E5 | 64 | . | . |
| MEAN | | | 70 | 74 | 55 |

# Moderate Environments




U.S. Department of Agriculture, National Agricultural Statistics Service

# Low Phytate Soybeans: *Can we solve the germ problem?*

- Low phytate soybeans can have poor G&E.
- Not all LP lines have poor G&E.
- Natural selection may not improve G&E in early generations.
- Pedigree selection may improve G&E in LP soy pops.
- Parents should contribute high G&E potential.
- Mid-Atlantic may be good environment for production of LP soybeans.

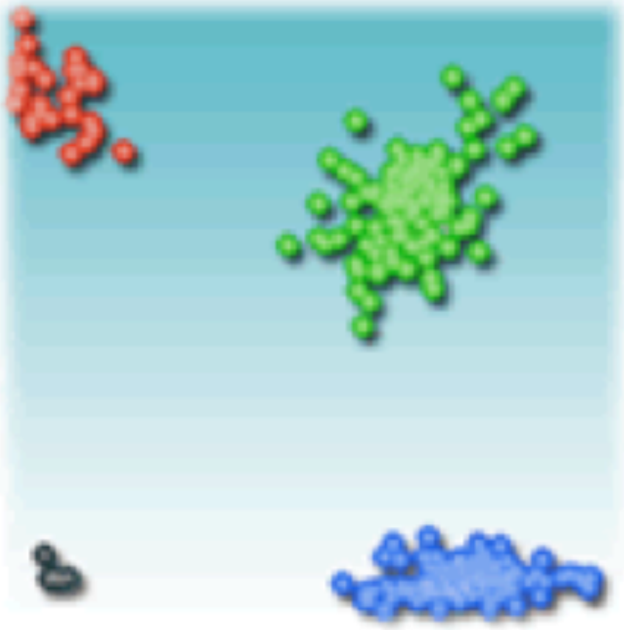
# New Colorimetric Phytate Method

| | Phytate | | Phytate | |
|---|---|---|---|---|
| | ---- µg P $g^{-1}$ ---- | | ---- µg P $g^{-1}$ ---- | |
| Genotype | Fe Method Mean | Fe Method Rank | HPIC Method Mean | HPIC Method Rank |
| S04-053-05 | 1032 | *1* | 860 | *1* |
| 04-05N32 | 1182 | *2* | 1137 | *2* |
| 5601T-BC1 | 1406 | *3* | 1282 | *3* |
| V03-5906 | 2272 | *4* | 1887 | *4* |
| V03-5901 | 2344 | *5* | 2092 | *5* |
| V03-5900 | 2387 | *6* | 2058 | *6* |
| 5601T | 3284 | *7* | 2897 | *7* |
| Essex | 3489 | *8* | 2947 | *8* |

# KASPar SNP Assays:
# *MIPS1, Lpa1, Lpa2*

**KASPar SNP Genotyping System and KASPar Direct real-time PCR system**

The KBiosciences PCR SNP genotyping system is a novel homogeneous fluorescent genotyping system. We utilise a unique form of allele specific PCR that is distinct and different to conventional ARMS (Patent pending). It has been developed at KBiosciences and is currently in use on a daily basis. It offers the simplest and most cost effective way to determine SNP genotypes in the laboratory.



Maupin, L.M., M.L. Rosso, C. Shang, and Katy M. Rainey. 2011. Genotype × environment interaction and stability of phosphorus concentration across twelve environments in two soybean germplasm sources with modified phosphorus composition. Crop Sci. Accepted.

Maupin, L.M., and Katy M. Rainey. 2011. Seedling emergence of two soybean germplasm sources with modified phosphorus composition. Crop Sci. Accepted.

Maupin, L.M., M.L. Rosso, and Katy M. Rainey. 2011. Environmental effects of soybean with modified phosphorus and sugar composition. Crop Sci 51:1-9.

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Rosso, M.L., S. Burleson, L. Maupin and Katy M. Rainey. 2011. Development of Breeder Friendly Markers for Selection of Low Phytate Soybeans. Molecular Breeding. *Submitted*.

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  - Eastern VA AREC
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  - Dr. Chao Shang, VA Tech
  - Dr. Rory Maguire, VA Tech
  - ARS, Raleigh
- **Effort**
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  - Dr. Luciana Rosso
  - Dr. Saghai Maroof
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  - Ted Lewis
  - Melissa Woolard
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