



Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Community Access to a Barrel Medic (*Medicago truncatula*) Core Germplasm Collection & Its Associated Information

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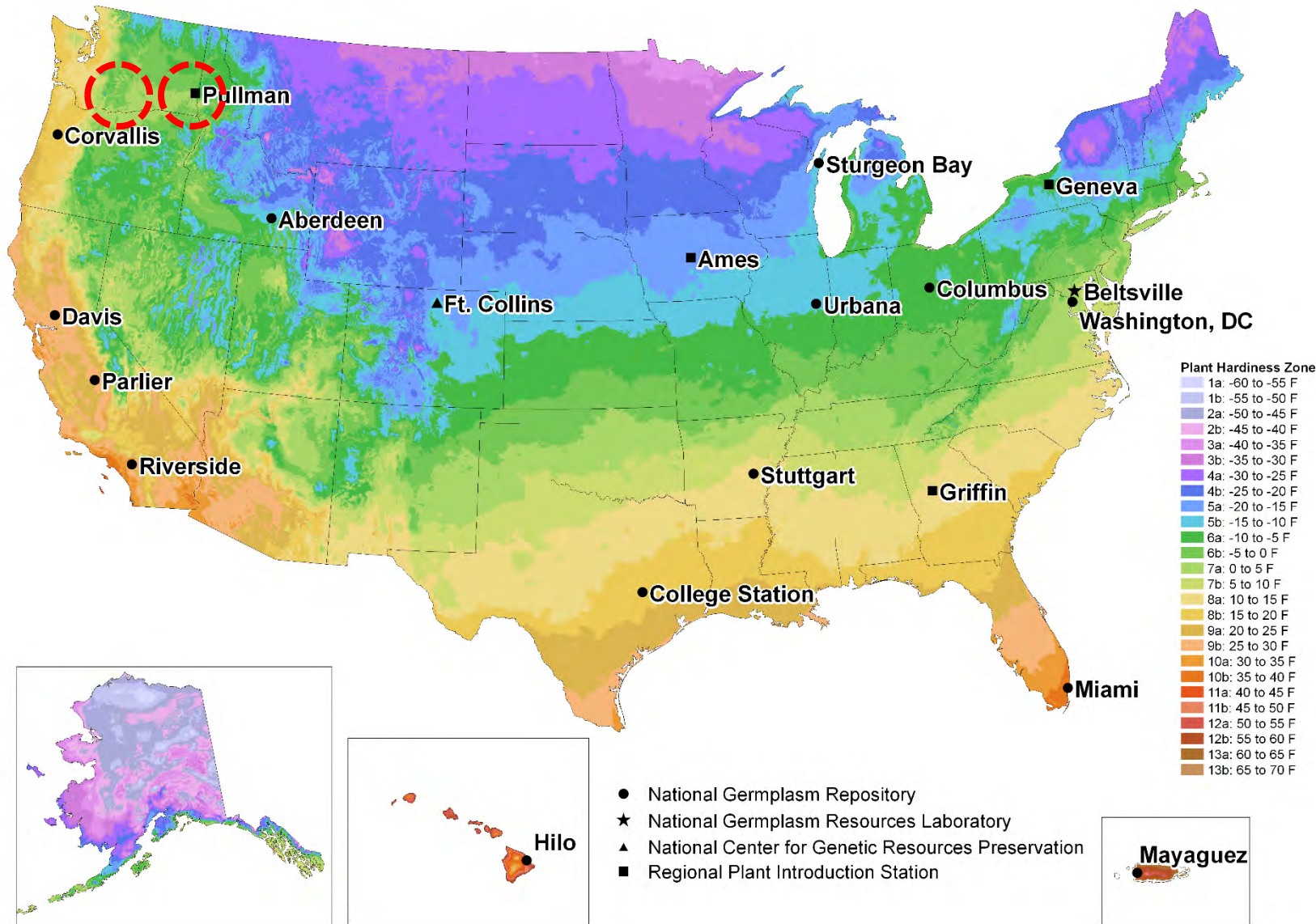
North American Alfalfa Improvement Conference, Trifolium Conference, and Grass Breeders Group - Stillwater, MN (July 2026)



BREEDING
Insight



National Plant Germplasm System (NPGS)



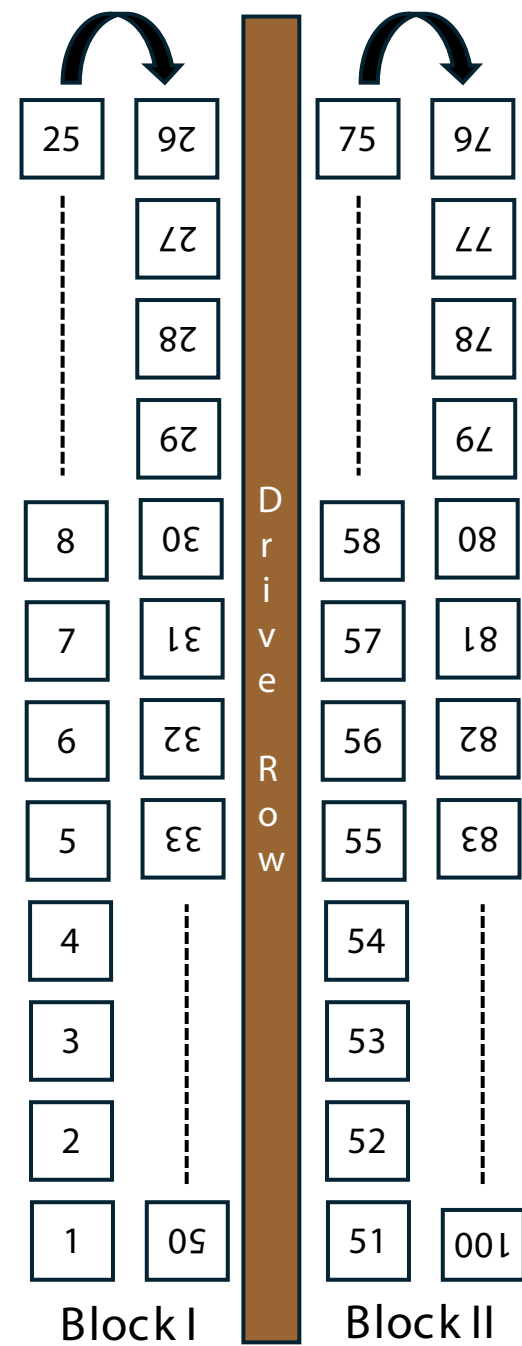
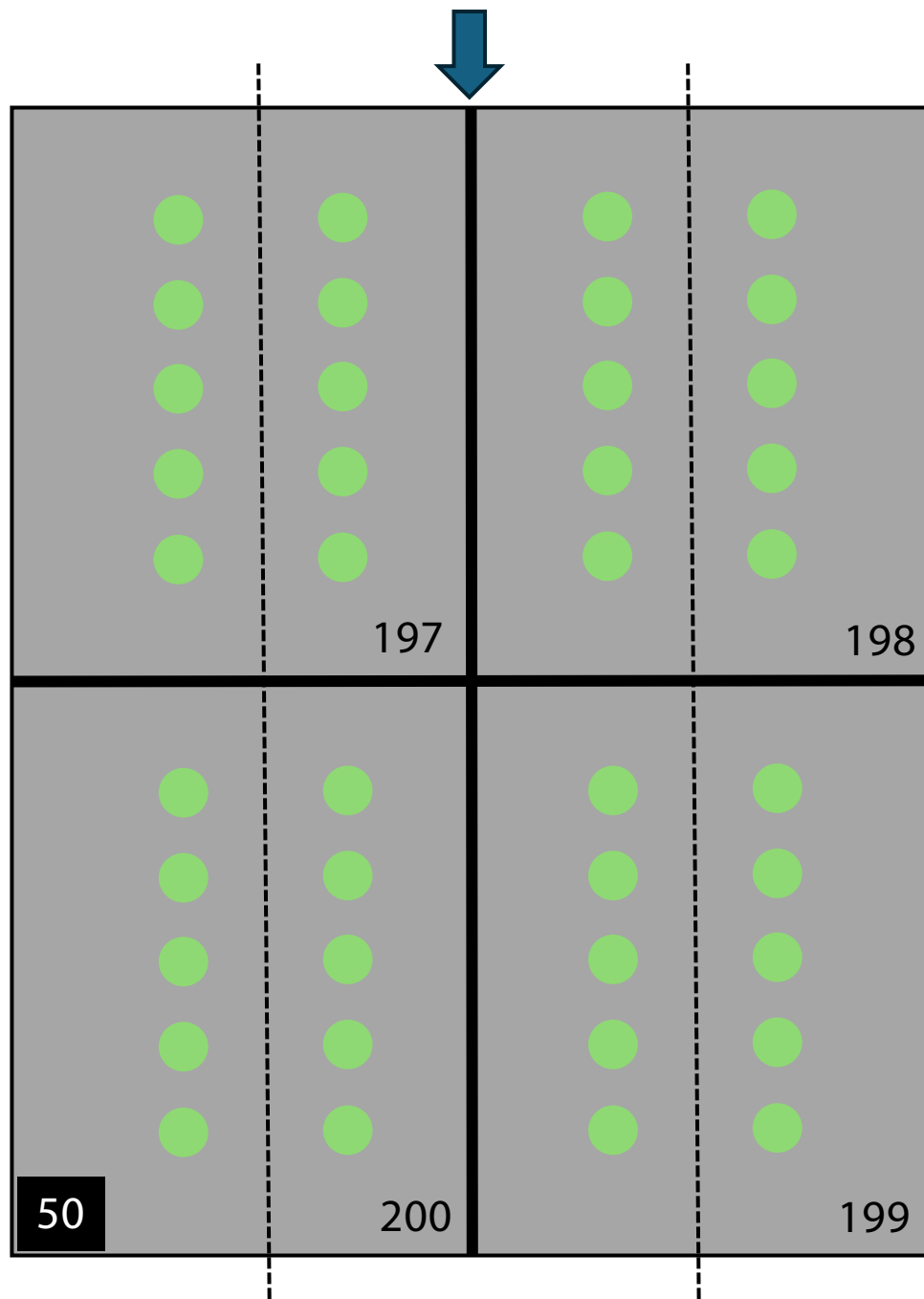
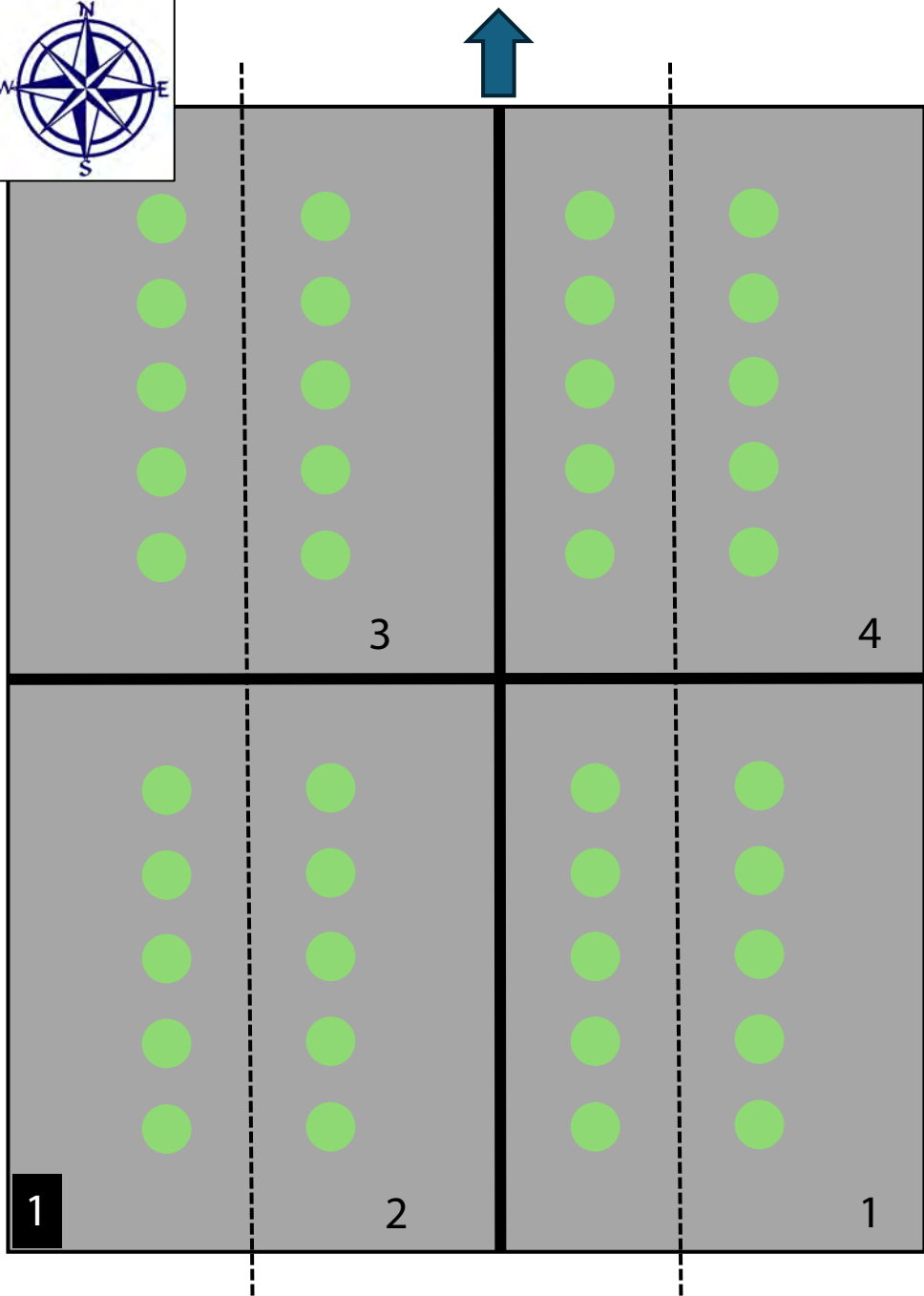
- 20 sites across nation
- >600K acc. & >16K spp.
- Crops and wild relatives
- 70+ year partnership
Land-Grant Universities,
and State Agricultural
Experiment Stations
- Long-standing
partnerships with
commodity groups and
agricultural industries in
those regions

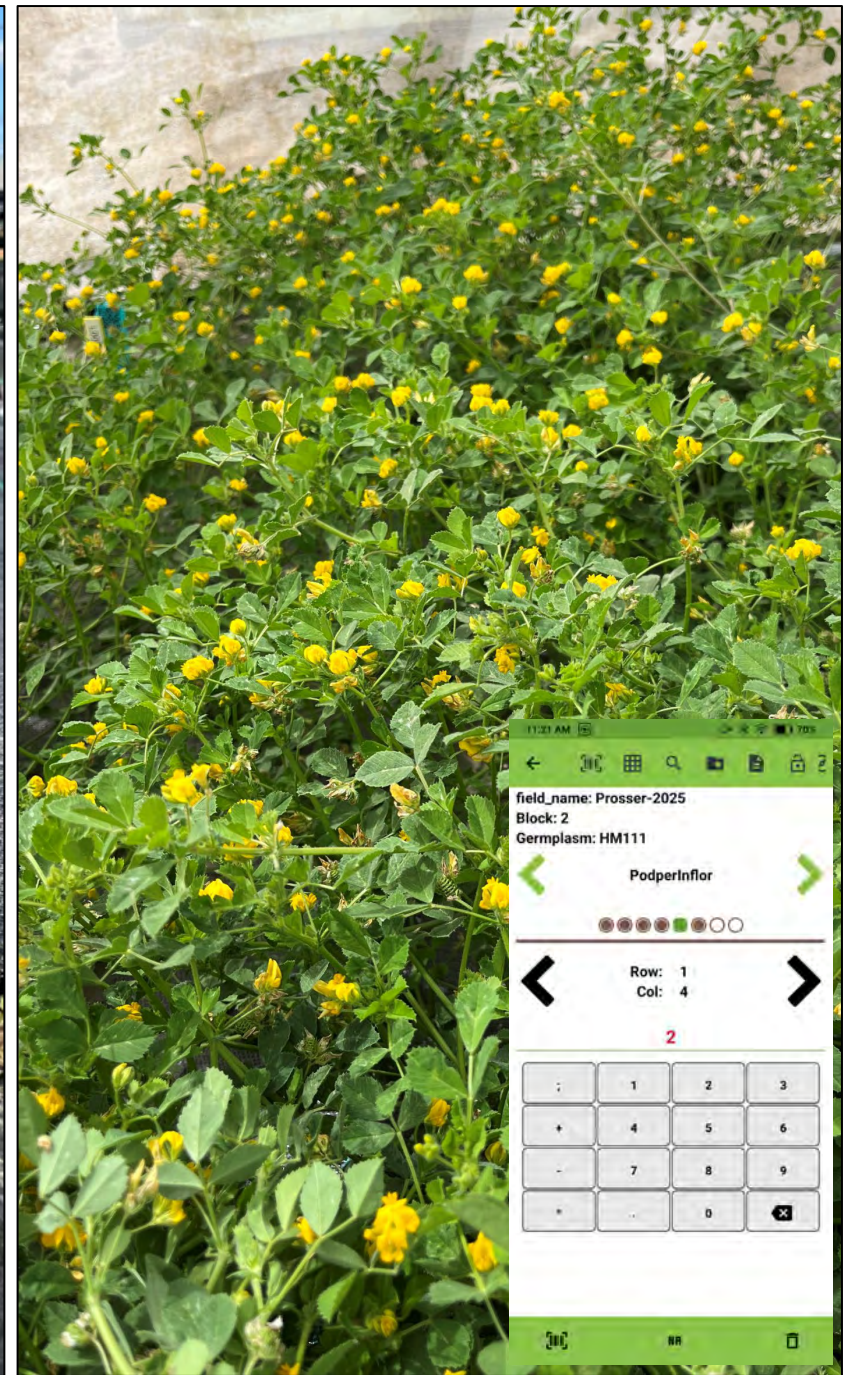


Why *Medicago truncatula*?

- *Medicago truncatula* Gaertn. – model plant species
 - First legume sequenced; nitrogen fixation, alfalfa relative*
- 192-accession nested core collection assembled by INRAE
 - Representative of diversity for species from native region
 - Could no longer manage and was going to be lost (N. Young)
 - Part of HAMAP project with large SNP datasets available
- “Recently” (2019) NPGS acquired small amounts of seed
- Opportunity to regenerate/characterize full core
- Marker trait associations with phenotype/genotype data

*Young et al. (2011). The *Medicago* genome ... *Medicago truncatula* and *M. sativa* share a highly conserved syntenic relationship. ...the order and orientation of genes across their chromosomes are extensively colinear, ... DOI: [10.1038/nature10625](https://doi.org/10.1038/nature10625)





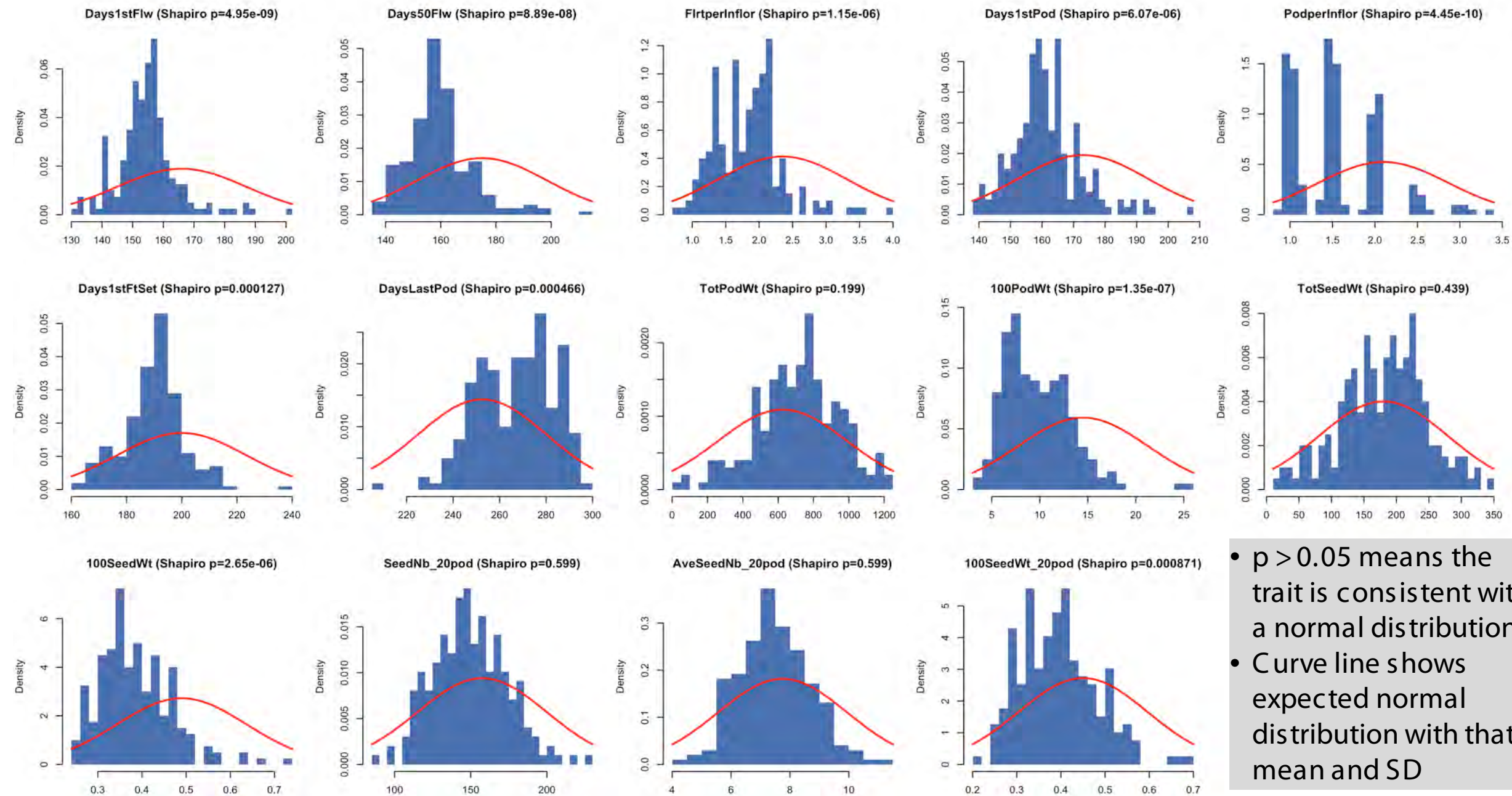


Phenotypic traits	Phenotypic traits	“ Agronomic ” traits	Description
Days to first flower	Yellow flower intensity	Pod yield	Total pod weight after combining ha
Days to first mature pod			
Days to 50% flowering		100-pod weight	Weight of a representative 100-pod
Days to last mature pod			
Early vigor		Seed yield	Total seed weight after combining h
Flowers per inflorescence	Leaflet margin		
Pods per inflorescence	Leaflet shape	100-seed weight	Weight of a representative 100-seed
Growth habit	Leaflet marker color		
Within plot heterogeneity	Leaflet marker position	Seed per pod	Mean number of seed per pod from
Plant count harvest summer	Leaf surface hairiness		
	Stipule shape	Germination rate	Measurement, in days, or how quic
	Pod spininess		
	Pod shape	Germination %	Measurement of total germination f







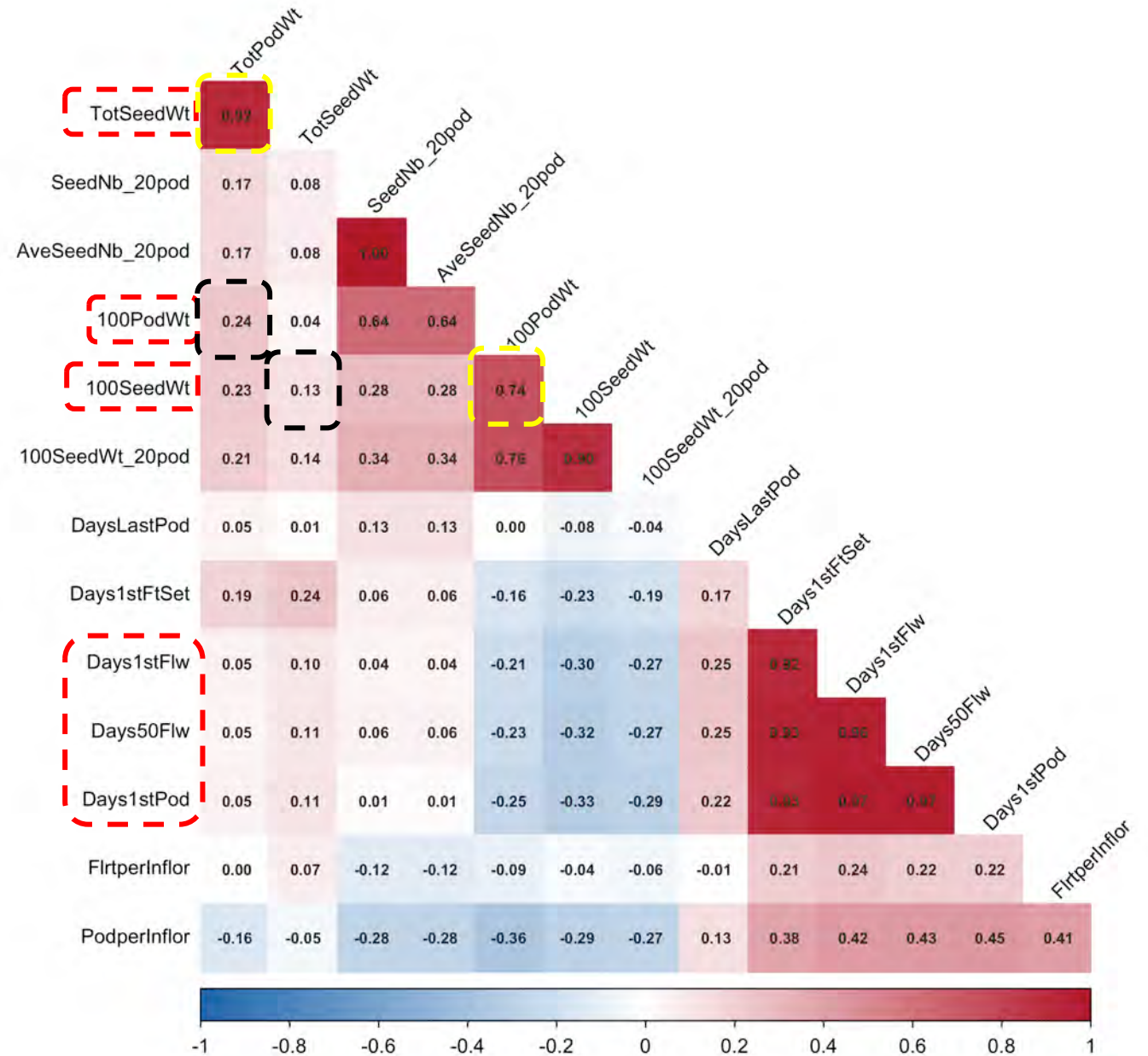


- $p > 0.05$ means the trait is consistent with a normal distribution
- Curve line shows expected normal distribution with that mean and SD

Trait Correlation

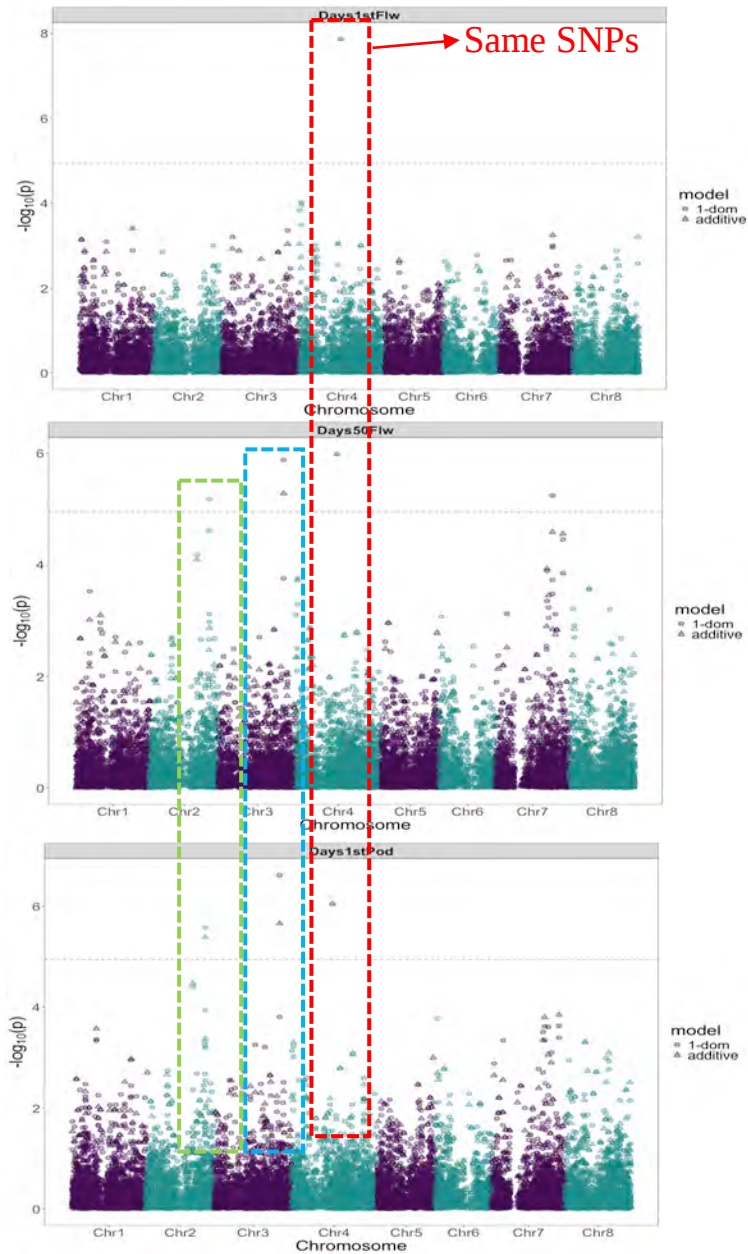
- Pearson correlation coefficients (r) among 14 traits – calculated from BLUE values
- Flowering-related traits were highly correlated (>0.90)
- Yield-component traits showed varying degrees of correlation
 - TotSeedWt and TotPodWt = 0.92
 - 100SeedWt and 100PodWt = 0.74
 - 100PodWt and TotPodWt = 0.24
 - 100SeedWt and TotSeedWt = 0.13
- AvgseedNb_20pod is weakly correlated to TotSeedWt and TotPodWt

* These observations appear to indicate that pod number is the driver of yield [as TotSeedWt = (pod number) × (seeds per pod) × (weight per seed)]



Marker trait associations (GWAS)

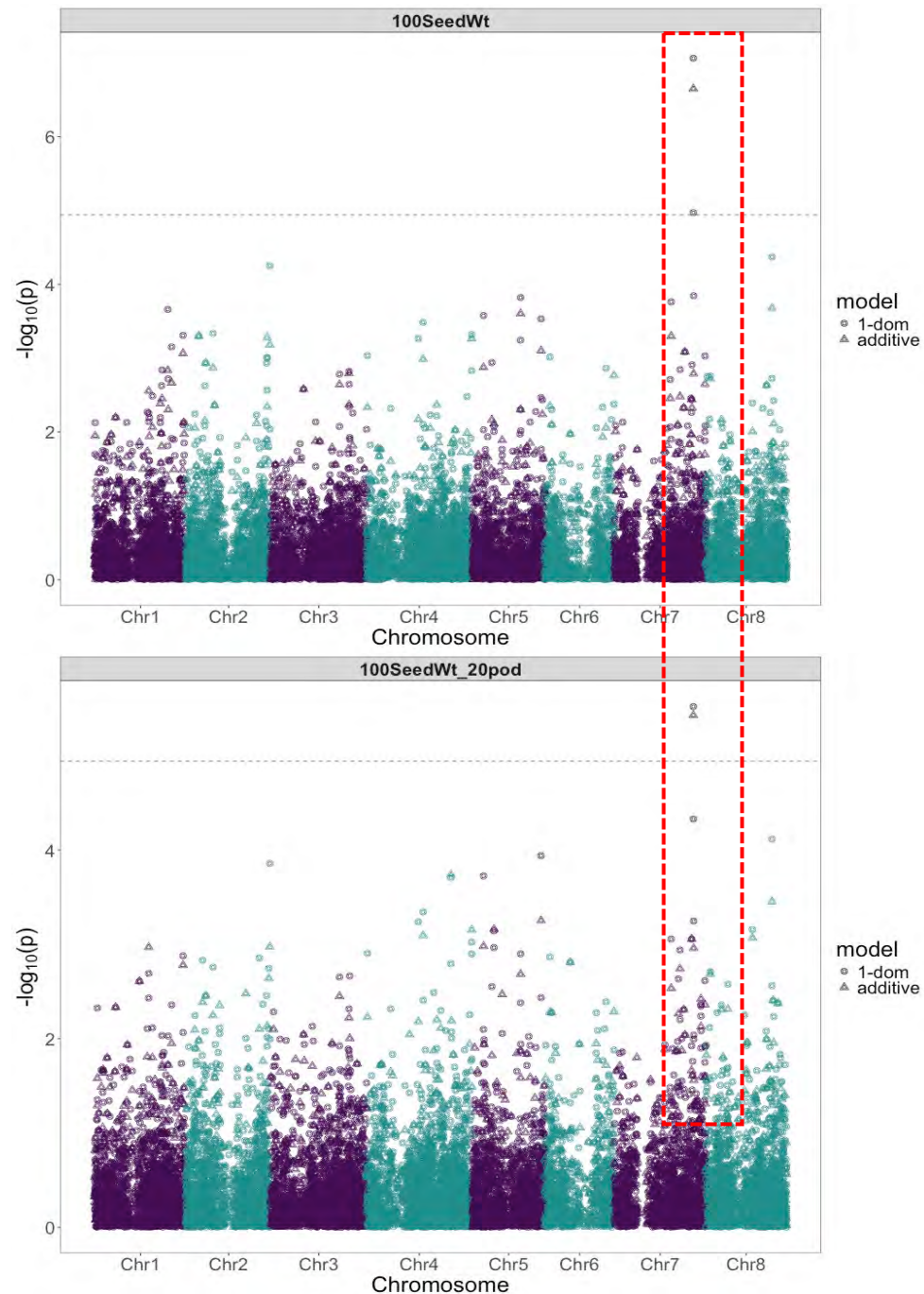
- Genome-wide associations study used GWASpoly R package
- 172 samples – not all 192 (200) have quality sequence data
 - [Legume information system - A17.gnm5.div.Epstein_Burghardt_2022](#)
- Phenotypic data for 14 quantitative traits
- 5,179 SNPs after quality control/filtering
- Control population structure by including PCs and kinship matrix (model selection based on BIC)
 - rrBLUP package: 'mixed.solve' function for maximum likelihood
 - Model: Pheno ~ PCs (fixed effect)+ kinship (random effect)
- GWAS using two genetic models: additive, 1-dom



Significant phenological SNPs

Trait	Model	Marker	Chr	Pos	Effect	PVE	pval
Days1stFlw	additive	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	10.557	16.3%	0
Days1stFlw	1-dom-alt	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	10.557	16.3%	0
Days50Flw	additive	freebayes-var-CM010650.1-49618725-G	Chr3	49618725	11.317	10.2%	0
Days50Flw	additive	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	11.356	12.3%	0
Days50Flw	1-dom-alt	freebayes-var-CM010650.1-49618725-G	Chr3	49618725	21.030	12.1%	0
Days50Flw	1-dom-alt	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	11.356	12.7%	0
Days50Flw	1-dom-ref	freebayes-var-CM010649.1-44891970-G	Chr2	44891970	21.918	8.2%	0
Days50Flw	1-dom-ref	freebayes-var-CM010654.1-43156942-T	Chr7	43156942	19.605	8.3%	0
Days1stPod	additive	freebayes-var-CM010649.1-44891970-G	Chr2	44891970	9.728	6.0%	0
Days1stPod	additive	freebayes-var-CM010650.1-49618725-G	Chr3	49618725	10.822	8.1%	0
Days1stPod	additive	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	10.732	15.1%	0
Days1stPod	1-dom-alt	freebayes-var-CM010650.1-49618725-G	Chr3	49618725	20.764	13.7%	0
Days1stPod	1-dom-alt	freebayes-var-CM010651.1-31032083-C	Chr4	31032083	10.732	15.6%	0
Days1stPod	1-dom-ref	freebayes-var-CM010649.1-44891970-G	Chr2	44891970	21.006	12.4%	0

*The same SNP identified by different models is highlighted in the same color



Significant “agronomic” SNPs

Trait	Model	Marker	Chr	Pos	Effect	PVE	pval
100SeedWt	additive	freebayes-var-CM010654.1-48529973-A	Chr7	48529973	0.054	14.9%	0
100SeedWt	1-dom-alt	freebayes-var-CM010654.1-48529973-A	Chr7	48529973	0.082	10.4%	0
100SeedWt	1-dom-ref	freebayes-var-CM010654.1-48529973-A	Chr7	48529973	0.110	16.1%	0
100SeedWt_20pod	additive	freebayes-var-CM010654.1-48529973-A	Chr7	48529973	0.052	12.3%	0
100SeedWt_20pod	1-dom-ref	freebayes-var-CM010654.1-48529973-A	Chr7	48529973	0.104	12.0%	0

*The same SNP identified by different models is highlighted in the same color

Take home message(s)

- Exciting project – collection diversity and because of collaborators
- The NPGS now has one of the world's most diverse and extensively characterized collections of the model plant species *M. truncatula*
- Seed quantities generated sufficient for many distribution years
- Seed is available and information will be in GRIN-Global
 - Already requested: soybean cyst nematode/divalent metal transporters
- Marker trait associations identified will provide insight into genic regions controlling those traits with possible links to alfalfa
- Collections are incredibly difficult to manage but our intent is to keep the *M. truncatula* collections in perpetuity – **please acknowledge the NPGS!**

THANK YOU!