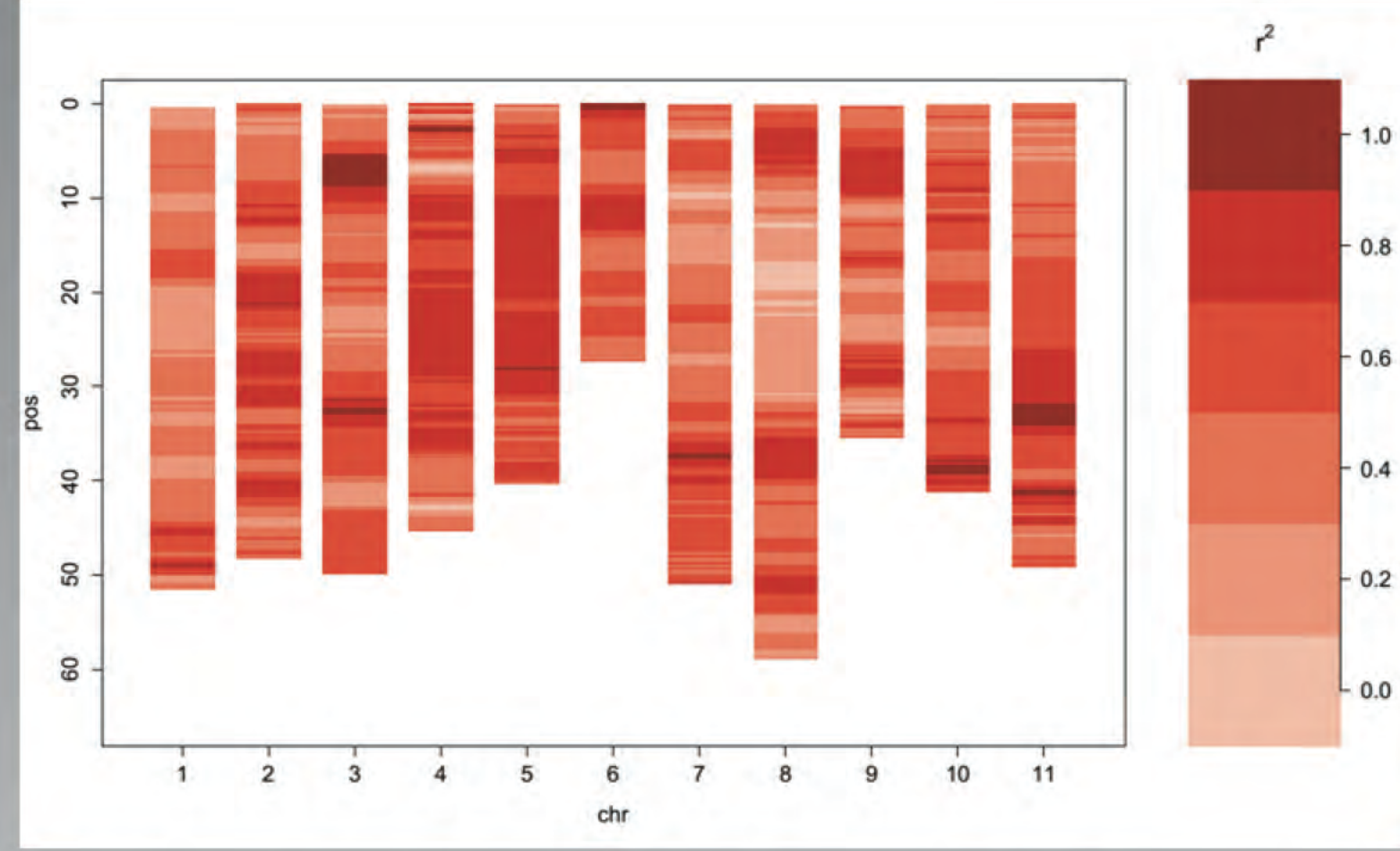
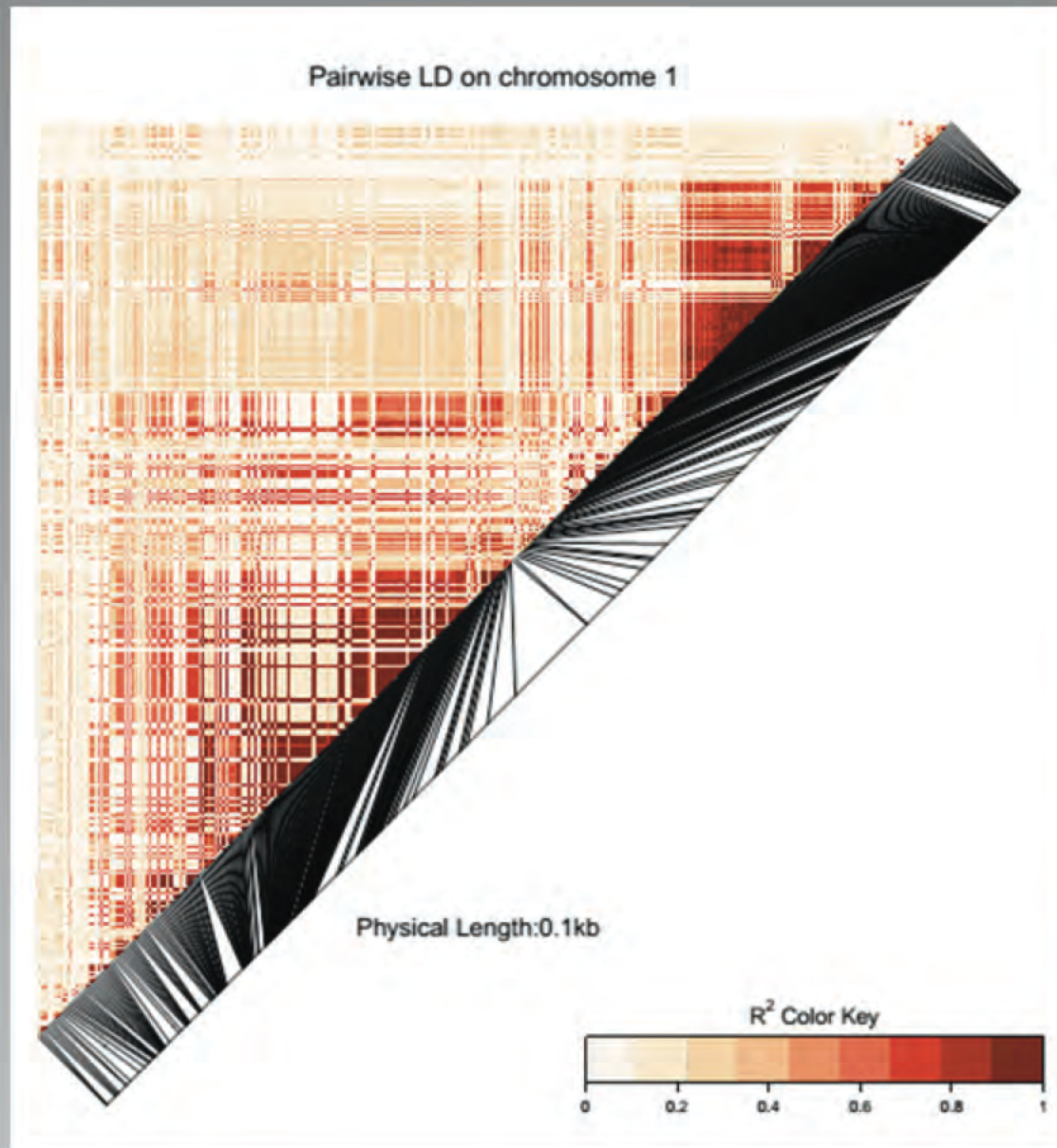
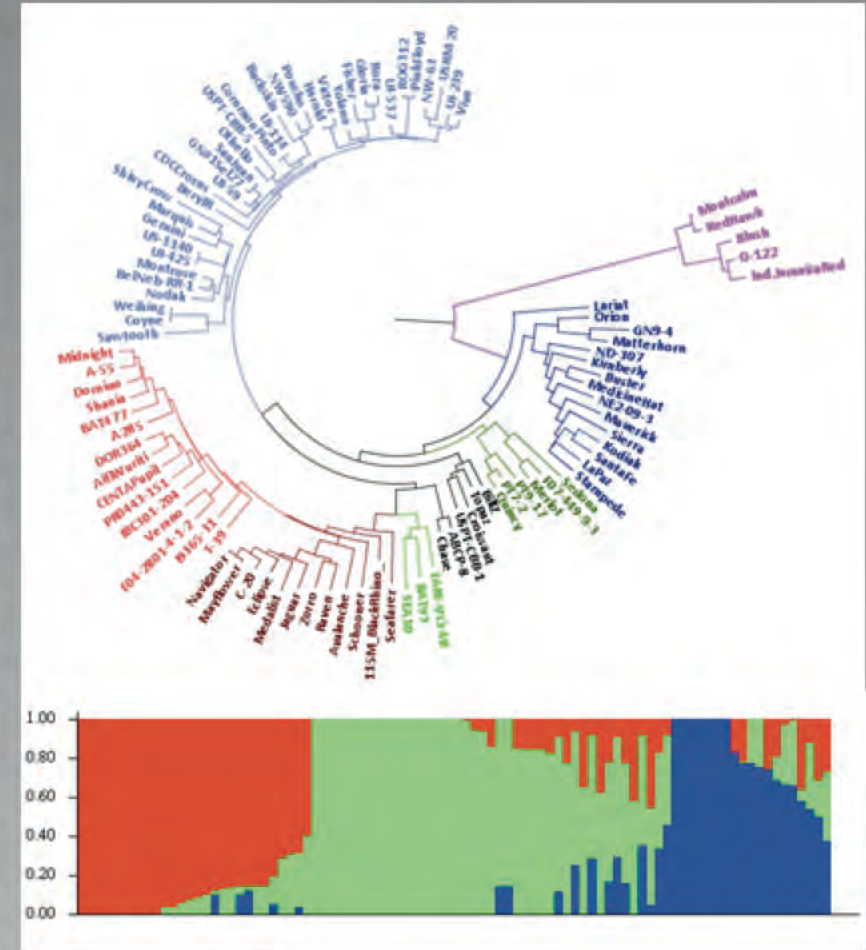




Breeding Resources



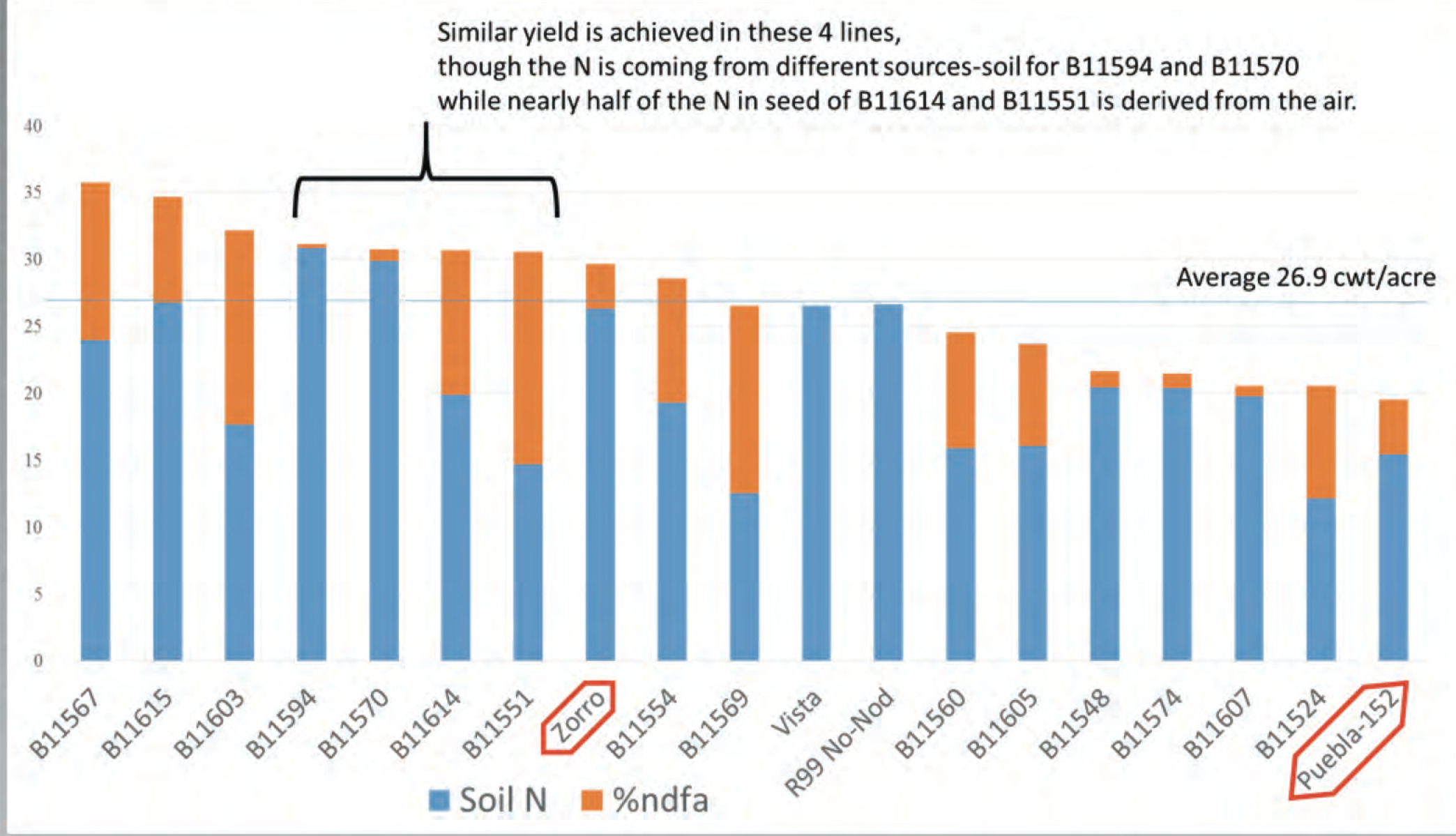
Parent selection. Analysis of the population structure of elite breeding materials across the US (above).



<http://www.beancap.org/>

Characterization of the haplotype blocks in chromosome Pv01 (left) and analysis of the variation of linkage disequilibrium (above) across the 11 chromosomes of the bean (*Phaseolus vulgaris* L.) genome

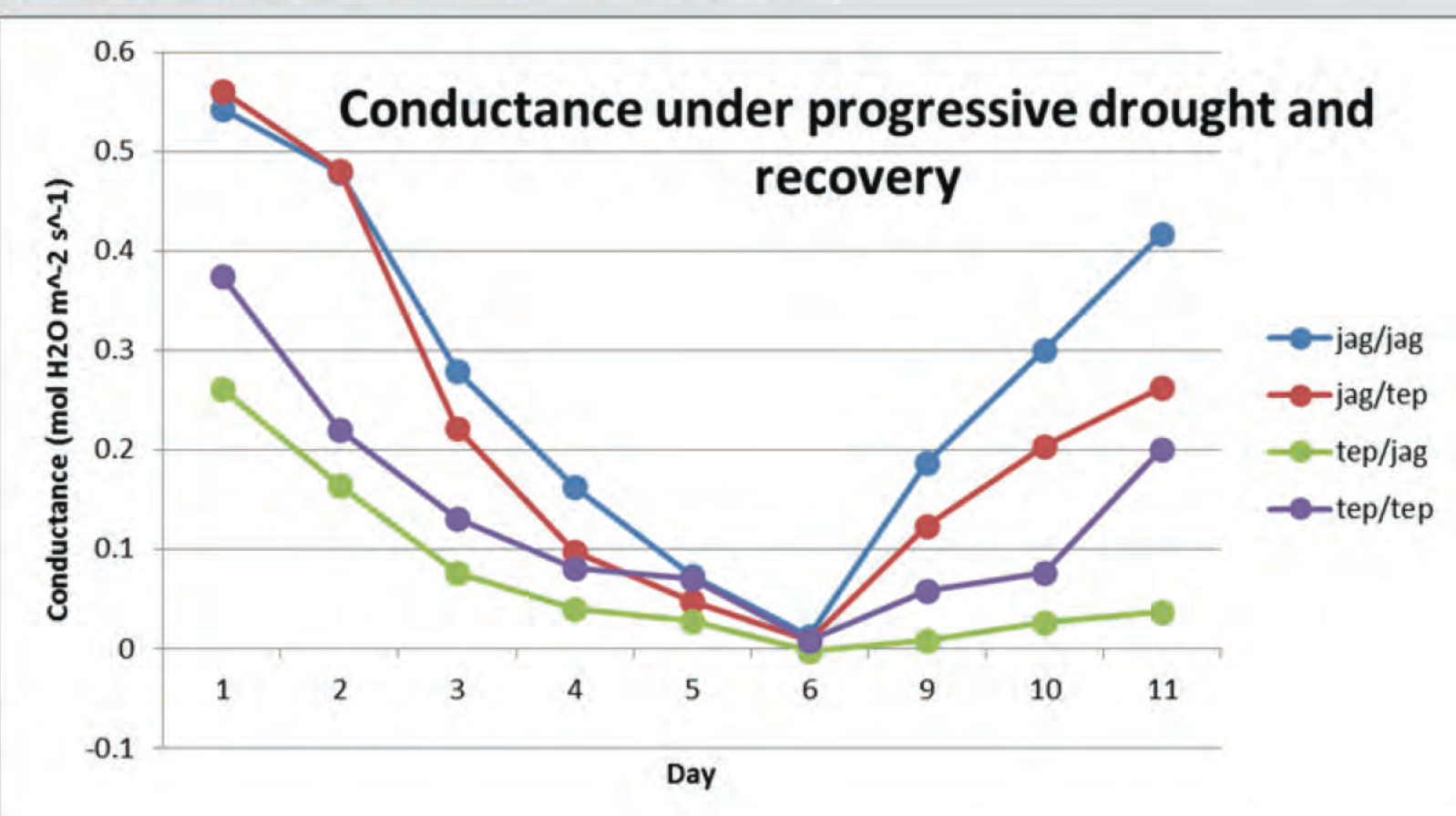
Symbiotic Nitrogen Fixation



Left. Yield and percent N derived from atmosphere (%ndfa) of select black bean recombinant inbred lines (RIL) developed by crossing Puebla 152 and Zorro (circled in red) grown in a low N field. The RILs vary in the proportion of N fixed from the atmosphere.

Left. Non-nodulated navy bean 'R99' (N fixation reference, left pot) and black bean lines grown using N-free media and nutrient solution with Rhizobia inoculant (right pot) and without inoculant (center pot).

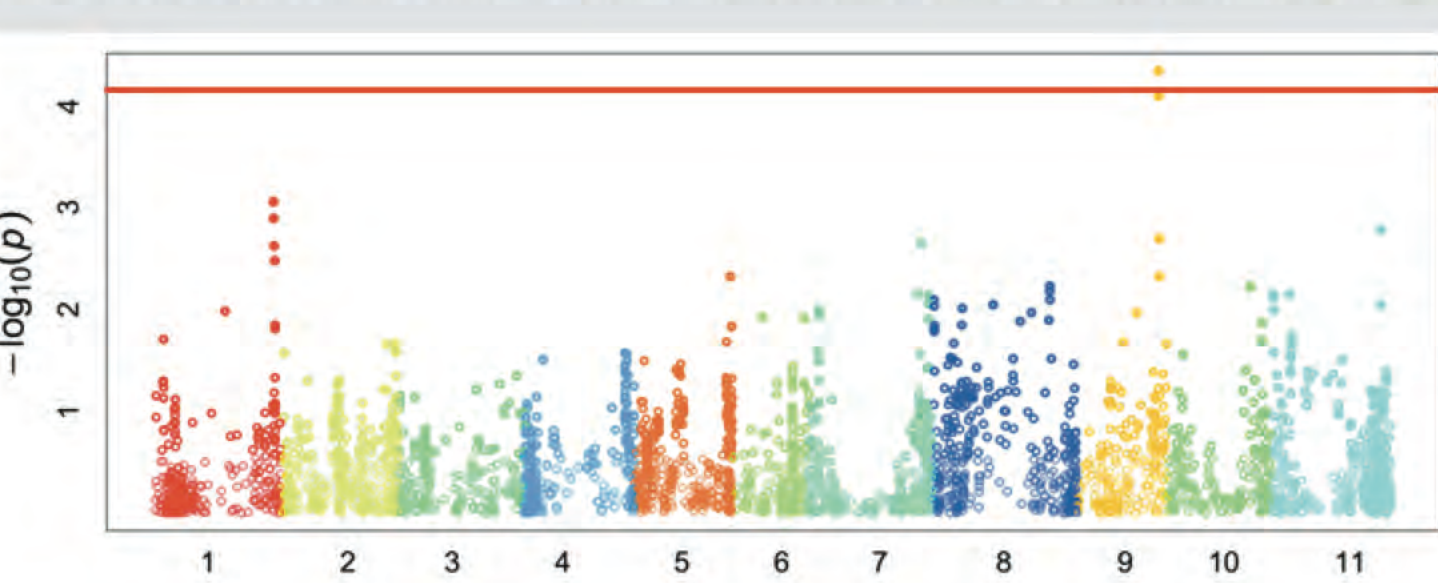
Drought Tolerance



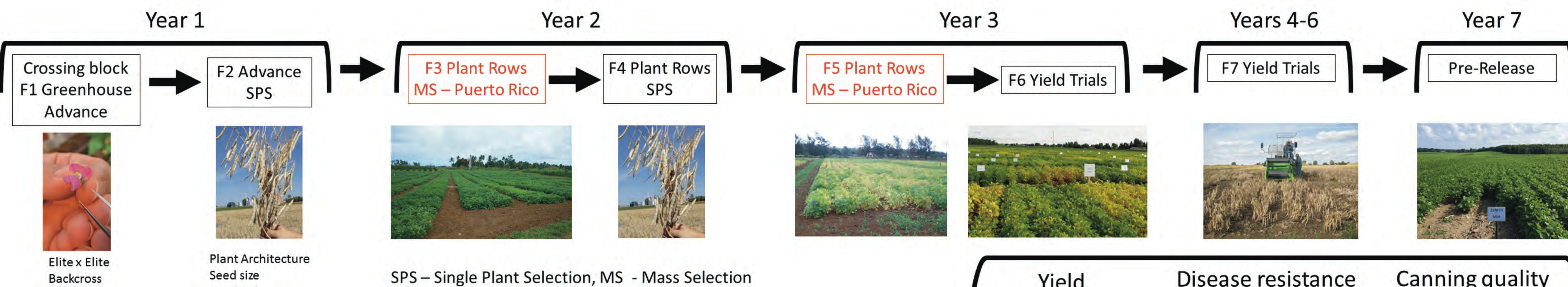
The stomatal conductance of reciprocal grafts (shoot/root) of drought susceptible *P. vulgaris* 'Jaguar' (jag) and the drought tolerant *P. acutifolius* 'Tepary' (tep), grown to maturity, and then exposed to progressively increasing water stress. Water withheld for seven days, then watering resumed on day 8 (left).



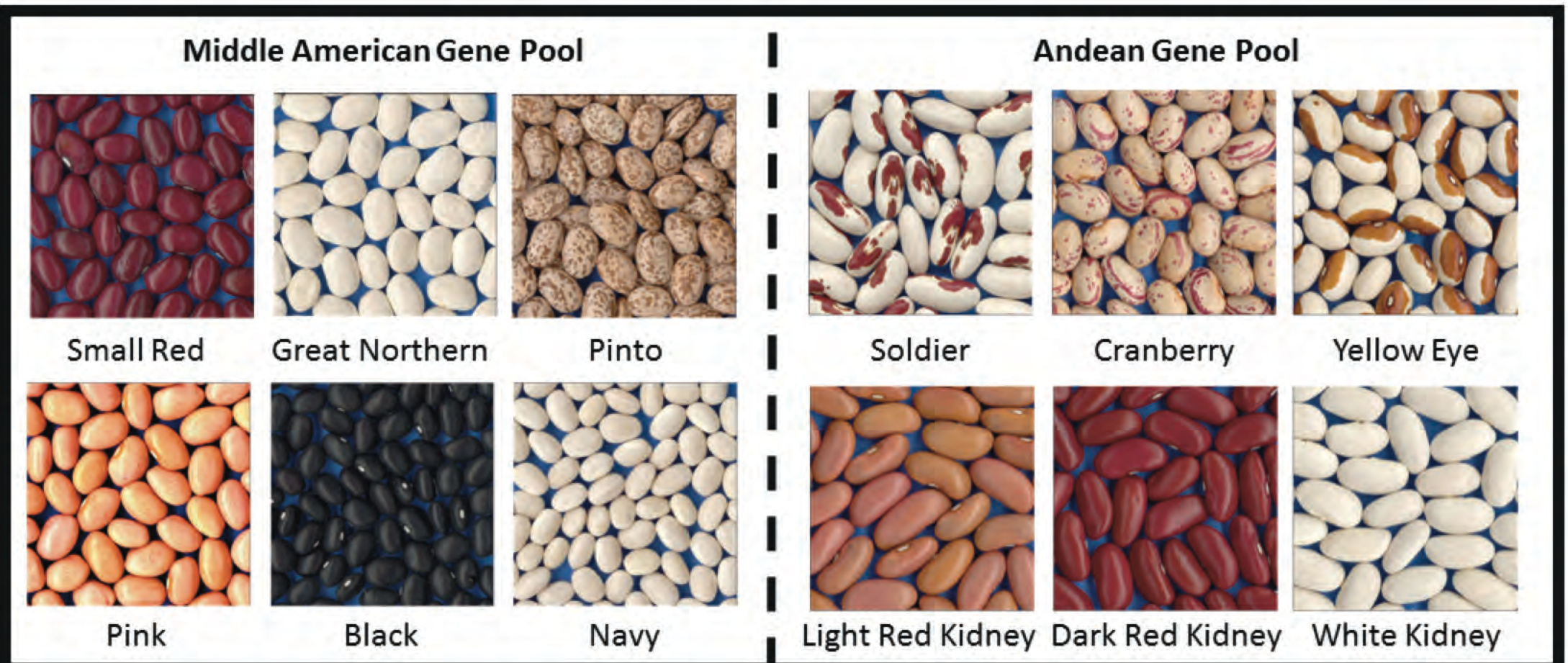
Testing of Photosyn device from Kramer lab (below)



Association analysis for seed yield on Pv09 under rainfed conditions in the Middle American BeanCAP diversity panel (above). Valerio Hoyos-Villegas



Over 40 varieties have been released by the program, scan this code to see the full list!



Dry bean market classes improved by the program (above)

The Breeding Cycle
Information gained from the surrounding projects helps improve the breeding process

Yield

On-farm seed yield in the US between 1909-2012 (above)

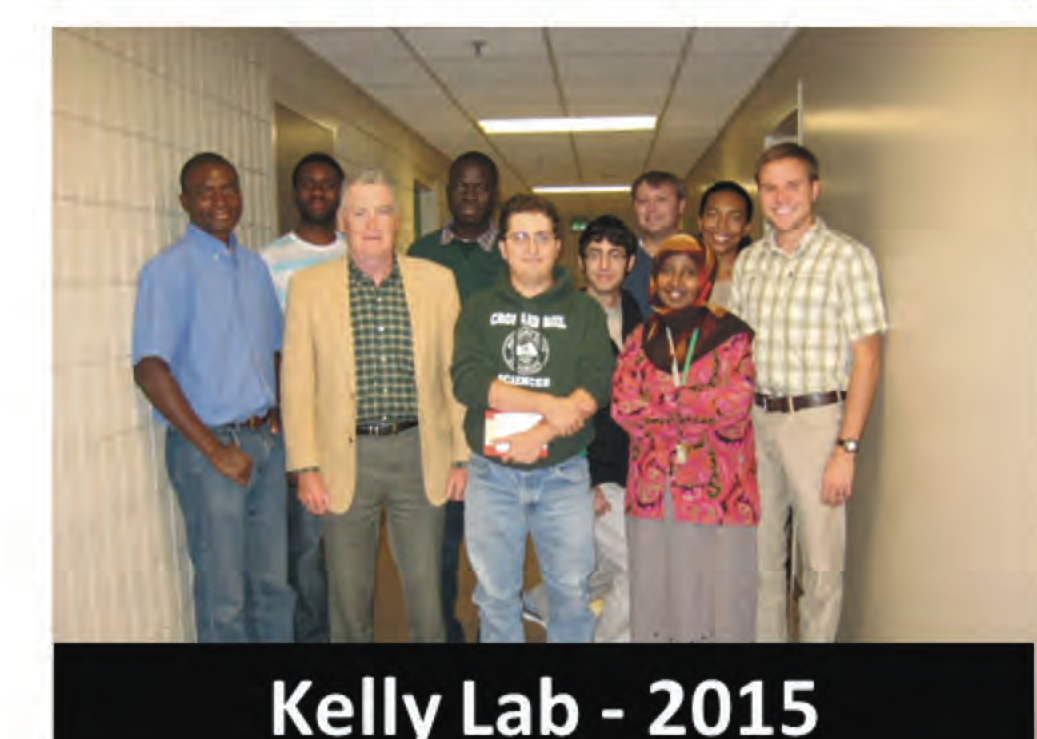
Disease resistance

- Anthracnose
- Rust
- Root rots
- Common bacterial blight
- Bean common mosaic virus
- White mold

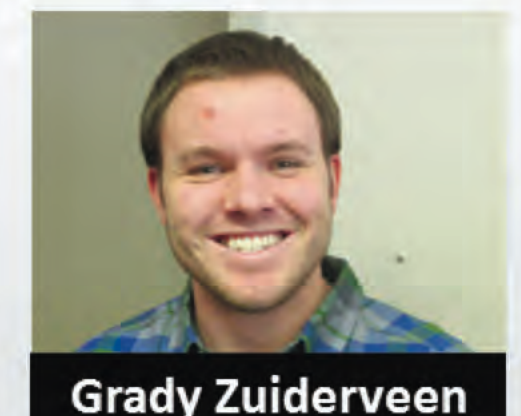
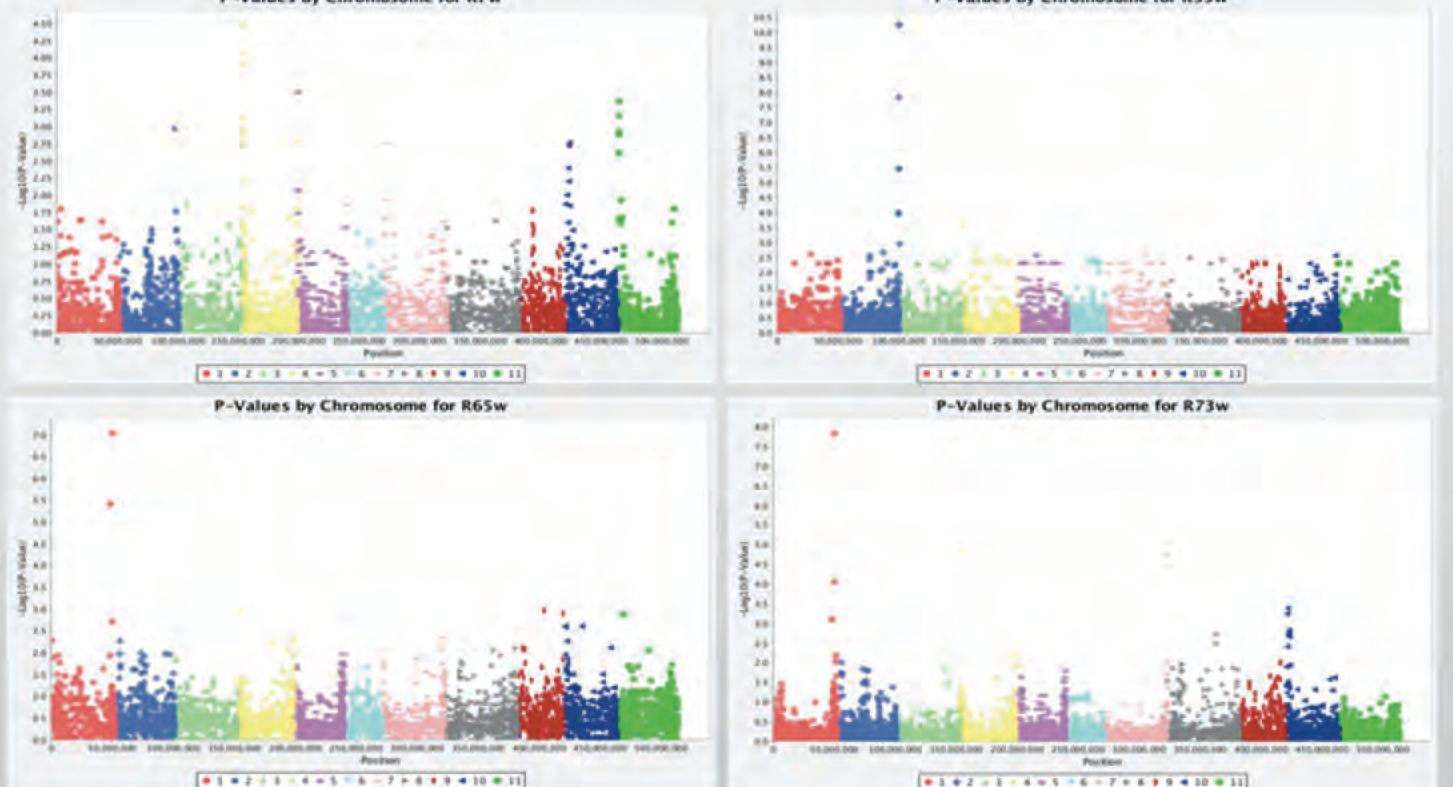
Canning quality

Common bacterial blight Marker Assisted Selection (MAS)

R – Resistant, S–Susceptible

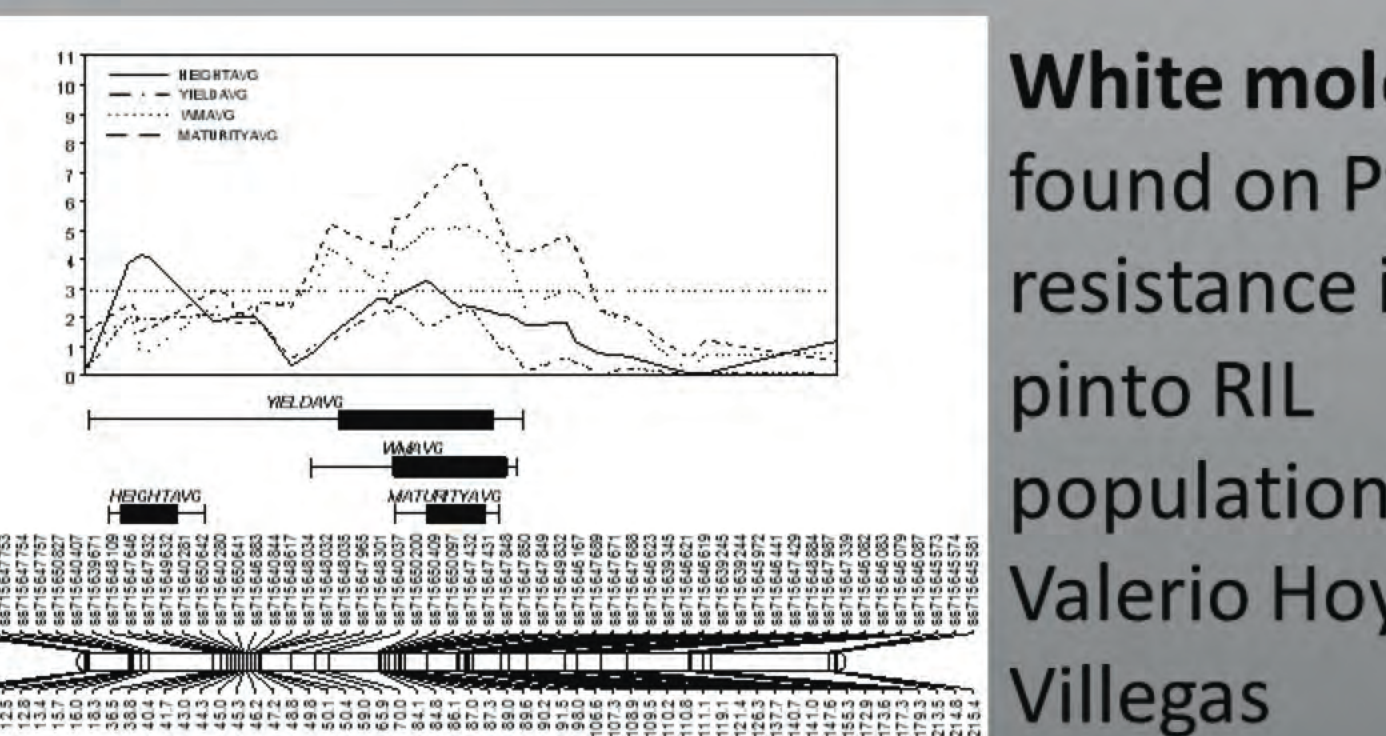
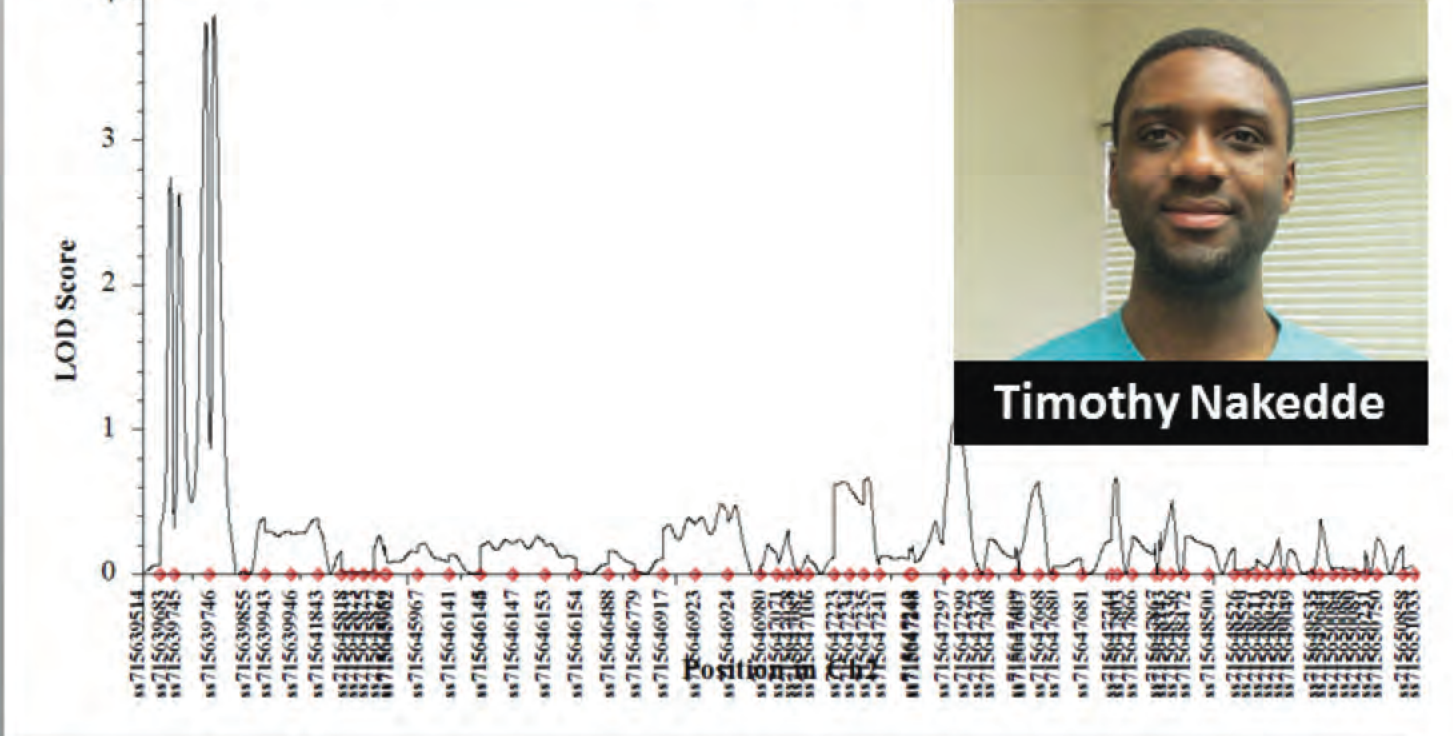


Disease Resistance



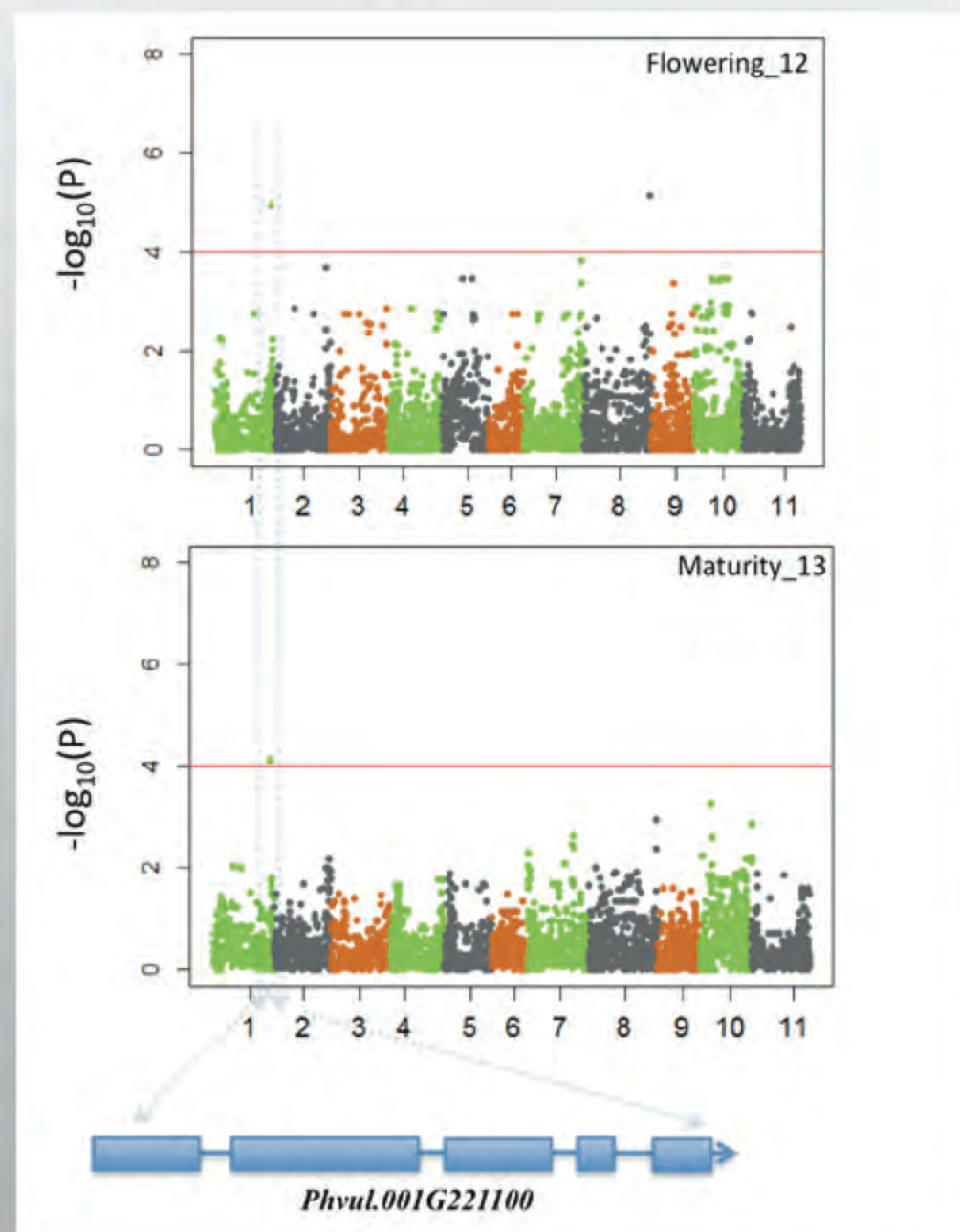
Anthracnose (above). Genomewide association analysis (left) for resistance to four anthracnose races using the Andean Diversity Panel (ADP)

Fusarium root rot. Quantitative Trait Locus (QTL) for resistance detected on chromosome Pv02 (below) using a Puebla x Zorro RIL population.



White mold. QTL found on Pv03 for resistance in a pinto RIL population (left). Valerio Hoyos-Villegas

Flowering and Maturity



Association analysis showing significant SNP markers for flowering (top) and maturity (bottom) in field studies of the ADP. Model of candidate gene with high sequence similarity to *A. thaliana* gene phyA (photoperiod sensitivity control).



International Projects



Former student: Dr. Gerardine Mukeshimana, current Minister of Agriculture for Rwanda



<http://legumelab.msu.edu/>

Two major team efforts: The Feed the Future Legume Innovation Lab project is focused on improving genetic yield potential of Andean beans with increased resistances to drought and major foliar diseases and enhanced biological nitrogen fixation in Uganda and Zambia and developing common bean germplasm with resistance to the major soil borne pathogens in Rwanda and Uganda



Trainees, Borlaug LEAP Fellows