# Heat tolerance in common bean derived from interspecific crosses

## *(Beans have the potential to survive climate change)*

RESEARCH PROGRAM ON Grain Legumes

CGIAR


**ABSTRACT:**

***Many countries could experience unprecedented heat stress because of global climate change (Battisti and Naylor, 2009). Heat sensitivity in common bean is a major limiting factor that can reduce yield, quality, and lead to restricted geographic adaptation (Beebe et al., 2011). Interspecific lines developed with crosses between P. vulgaris and P. acutifolius were evaluated for their tolerance to heat stress. Results from field and greenhouse evaluation confirmed that Phaseolus acutifolius is an important and useful genetic resource for improving heat tolerance in common bean. Results from genomic analysis indicated the introgression of P. acutifolious genes into interspecific INB line that was used as a parent for developing heat tolerant SEF lines.***


## INTRODUCTION

- **Common bean (*Phaseolus vulgaris* L.) is the most important food legume, cultivated by small farmers and usually exposed to unfavorable conditions.**
- **Based on analysis using 19 global climate models, they concluded that, with current varieties, the area suited for bean production will have shrunk up to 50% by about 2050.**
- **With heat-tolerant beans, the reduction will be only 5%, even assuming conservatively that the tolerant beans can handle a temperature rise of only 3 degrees.**
- **In some parts of Africa and Latin America, farmers adopting the heat beaters will actually be able to expand production on land where it's normally too hot for beans.**
- **Tepary bean (*P. acutifolius*) is an important source of heat tolerance due to its evolution under dry and hot environments.**

## RESULTS

- **Phenotypic differences in response to heat stress were observed in common bean under field and greenhouse conditions**
- **Results from field and greenhouse evaluation confirmed that *Phaseolus acutifolius* is an important and useful genetic resource in improving heat tolerance (Figures 1 and 2).**
- **In common bean pollen formation and viability is the reproductive period most sensitive to heat.**
- ***P. acutifolious* introgression blocks detected on AM (Andean x Meso) inter-genepool and INB (interspecific) breeding lines (Figures 3 and 4)**

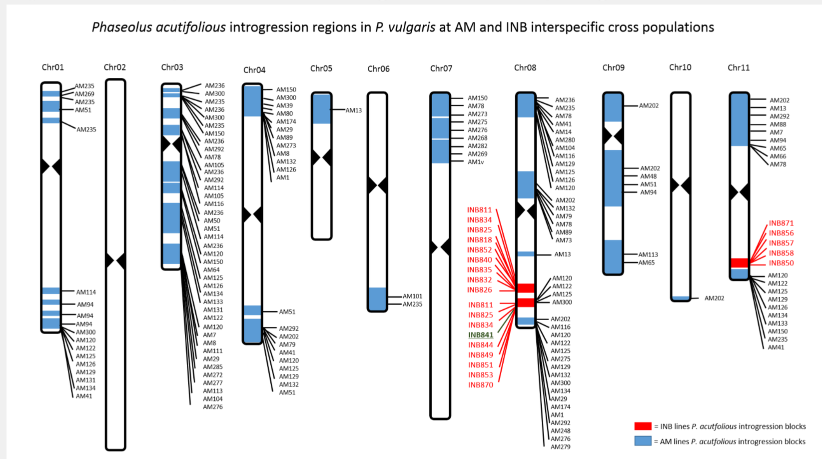


**Figure 3.** Introgression blocks of *P. acutifolious* detected in interspecific lines AM (blue) and INB (red) along the *P. vulgaris* genome.

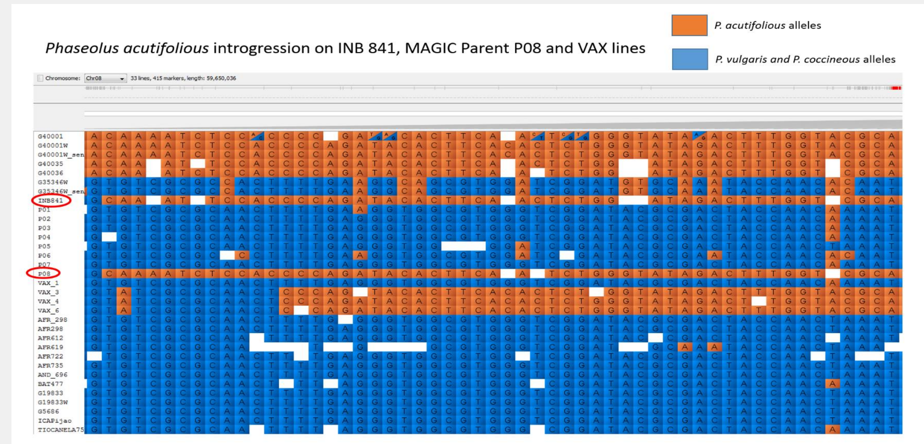



**Figure 4.** Introgression blocks of *P. acutifolious* (orange) detected on INB841, VAX and P08 interspecific lines compared to *P. vulgaris* (blue).

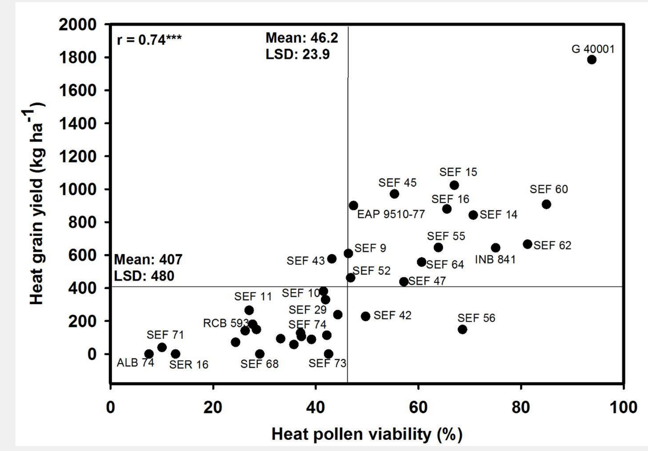



**Figure 1.** Effect of high temperature on grain yield of SEF lines and its relationship with pollen viability under field conditions, Armero, Colombia

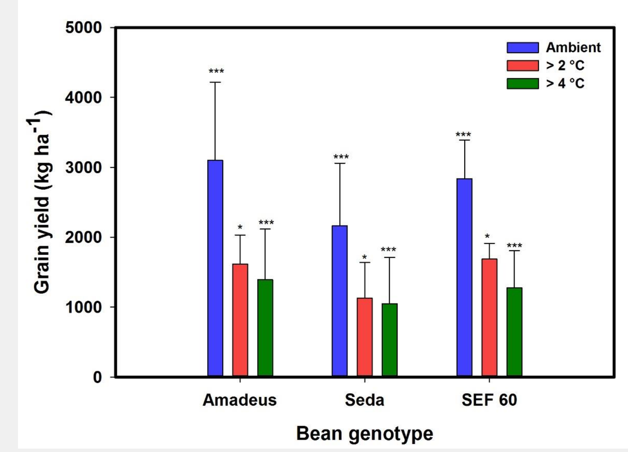
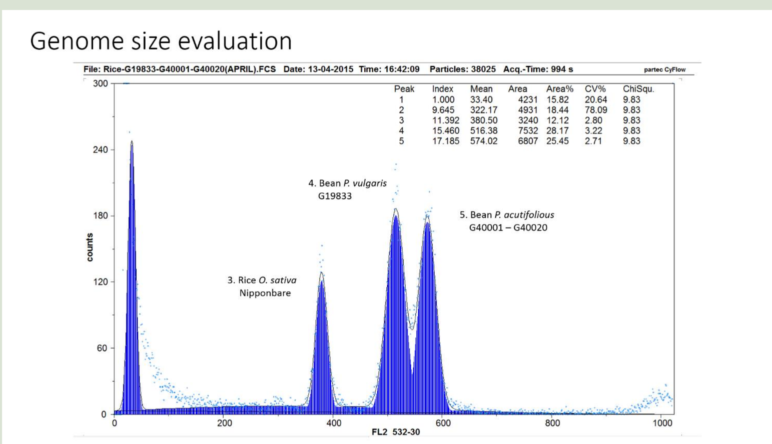
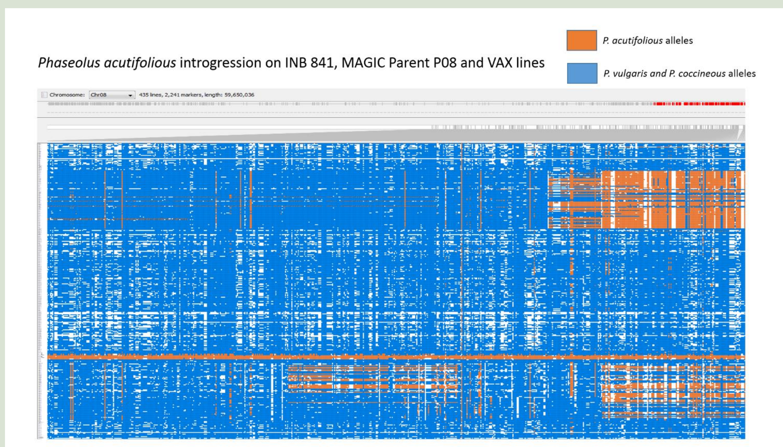


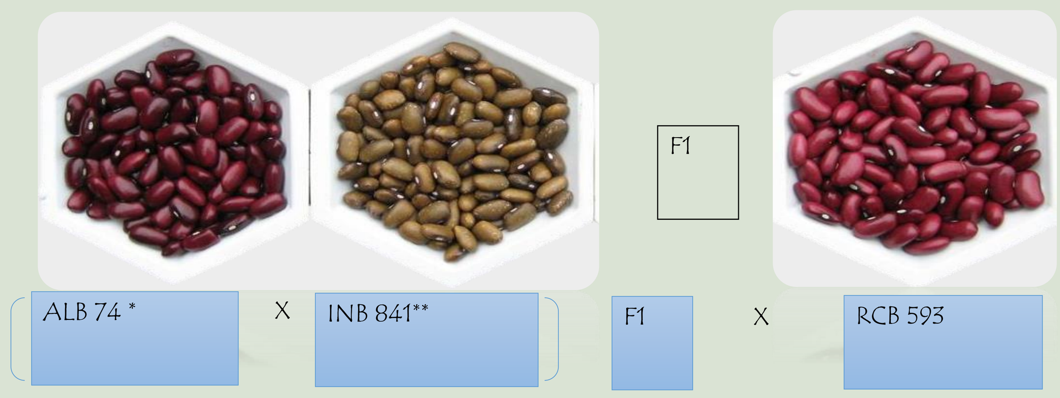

**Figure 2.** Effect of three different air temperatures on grain yield of three bean genotypes using controlled conditions at CIAT Palmira, Colombia.

## MATERIALS AND METHODS

- **Phenotyping for heat tolerance under field conditions at Armero, Colombia, using 36 SEF (Interspecific: *P. vulgaris x P. acutifolius x P. coccineus*) lines**
- **Phenotyping for response to heat stress in common bean was conducted under controlled conditions using two polycarbonate greenhouses established at CIAT headquarters**
- **Genome size measurements in addition with Whole Genome Sequencing (WGS) and Genotyping by Sequencing (GBS) data were analyzed with NGSEP to develop a SNPs marker data set along the bean genome to detect introgression blocks of *P. acutifolious* haplotypes in the *P. vulgaris* interspecific lines.**




* Interspecific with *Phaseolus coccineus*
** Interspecific with *Phaseolus acutifolius*

## DISCUSSION

- ***Phaseolus acutifolius* and its progeny presented higher pollen viability under heat stress**
- **Photosynthate mobilization from vegetative structures to pod formation and subsequently to grain formation are key processes in improving heat tolerance.**
- **Several genotypes that combine traits related to heat tolerance were identified for use as parents in the breeding program for this limitation.**
- **Several *P. acutifolious* introgression blocks were detected with interspecific lines on chromosomes 08 and 11.**
- **Genome size differences reflect the amount of genetic information hidden in tepary.**

## REFERENCES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