Evolutionary genomics and Biotechnology of Profilin cell-wall structural genes

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Abstract

Statement of the Problem:
In response to increased global demand for food, feed and fiber, there is a tremendous pressure on the agricultural system at present. Evolutionarily important phenomenon such as plant domestication and modern plant breeding has presumably narrowed the genetic diversity in nearly all crop plants. Extra-long and spinnable fiber traits of cotton have been selected under domestication of an agronomically inferior wild ancestor, followed by millennia of human-mediated selection.

Findings:
We measured temporal expression alterations in the fiber cells of wild and domesticated cotton, using a microarray platform that interrogates 42,429 unigenes. The distribution of differentially expressed genes across developmental stages was significantly different, and the prolonged fiber growth in the cultivated form is associated with the up-regulation of profilin cell-wall structural genes. Profilins play prominent roles in cell-wall maintenance through actin sequestering and cytokinesis. Evidently, evolutionary variations in the profilin exon/intron architecture were accomplished by '*exon/intron-gain*' and insertion/deletion during sequence-exonization. Further, ectopic expression of cotton *GhPRF1* gene in tobacco resulted in the hyperactivation of the apical meristem and early flowering phenotype with increased flower number in contrast to the WT plants. The *GhPRF1* transduced the key positive flowering regulator *AP1* gene *via* coordinated expression of *FT4*, *SOC1*, *FLC1* and *FT1* genes involved in the apical-to-floral meristem signalling cascade.

Conclusion & Significance:
Several of the transcriptomic differences between wild and domesticated cotton species suggest that replicated domestication of different species has resulted in overlapping, and parallel metabolic transformations. Results of transgenic overexpression of domestication-driven structural profilin gene provide a novel temporal perspective on apical meristem determinacy and flower development adding to our understanding the importance of profilin structural genes in the regulation of important phenotypic traits during plant development.

Selected Publications:

1. Pandey, D. K. and **Chaudhary, B.** (2017) Evolutionary expansion and structural functionalism of the ancient family of profilin proteins. ***Gene*** 626: 70-86

2. Pandey, D. K. and **Chaudhary, B.** (2016) A botanist's cognitive view on plant growth: cross-talk between developmental and sensitivity networks. ***American Journal of Plant Sciences*** **7**: 2307-2322

3. Pandey, D. K. and **Chaudhary, B.** (2016) Domestication-driven *Gossypium* profilin 1 (*GhPRF1*) gene transduces early flowering phenotype in tobacco by spatial alteration of apical/floral-meristem related gene expression. ***BMC Plant Biology*** 16: 1-21

4. **Chaudhary, B.**, Hovav, R., Flagel, L., Mittler, R. and Wendel, J.F. (2009). Parallel evolution of oxidative stress-related genes in fiber from wild and domesticated diploid and polyploid cotton (*Gossypium*). ***BMC Genomics*** 10:378

5. **Chaudhary,B.**, Flagel, L., Stupar M. R., Udall, J.A., Verma, N., Springer, N.M. and Wendel, J.F. (2009). Reciprocal silencing, transcriptional bias and functional divergence of homoeologs in polyploid cotton (*Gossypium*). ***Genetics*** *182:503-517*

6. **Chaudhary, B.**, Hovav, R., Rapp, R., Verma, N., Udall, J.A. and Wendel, J.F. (2008). Global analysis of gene expression in cotton fibers from wild and domesticated *Gossypium barbadense*. ***Evolution and Development*** 10(5) :567-582

7. Hovav*, R., **Chaudhary*, B.**, Udall, J.A., Flagel, L. and Wendel, J.F. (2008). Parallel domestication, convergent evolution and duplicated gene recruitment in allopolyploid cotton. ***Genetics*** 179:1725-1733 (***equal contribution**)

8. Hovav, R., Udall, J. A., **Chaudhary, B.**, Rapp,R., Flagel, L. and Wendel, J.F. (2008). Partitioned expression of duplicated genes during development and evolution of a single cell in a polyploid plant. ***Proc. Natl. Acad. Sci. USA*** 105:6191-6195

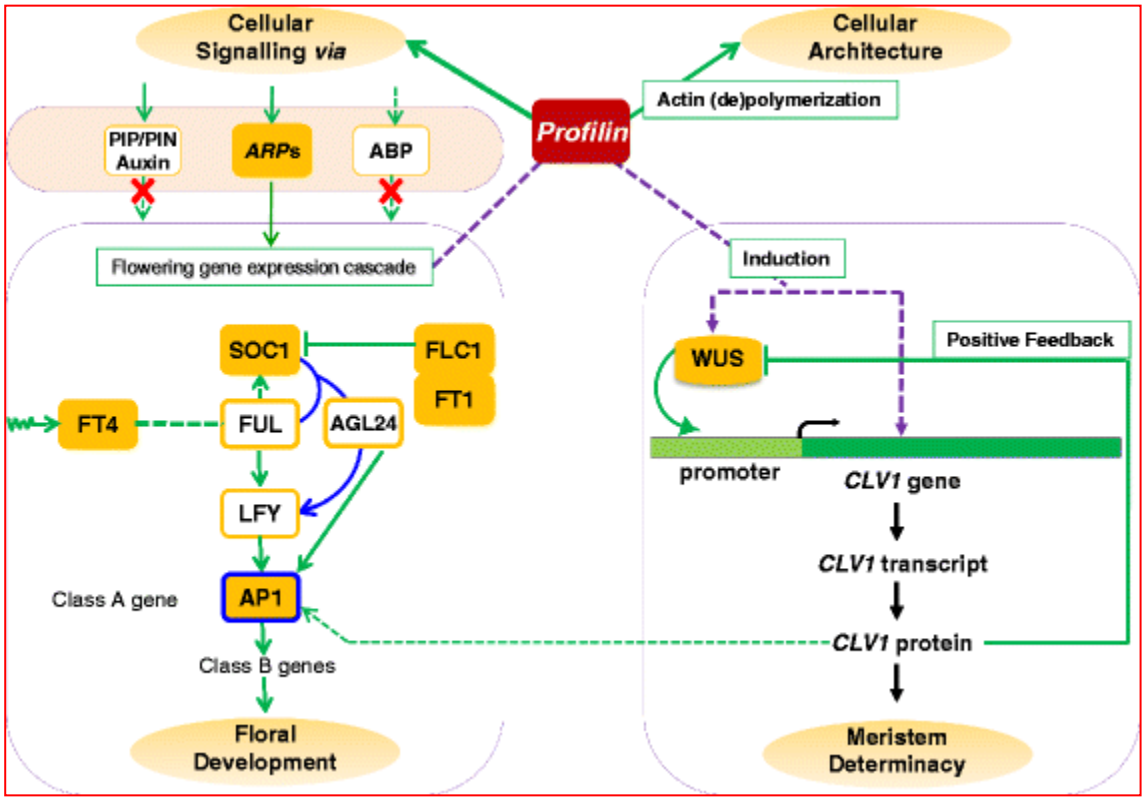
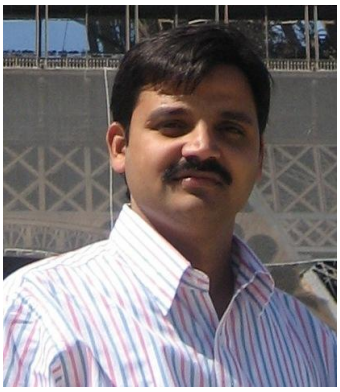


Fig. 1 Molecular framework for profilin-mediated activation of apical and reproductive meristem.

Biography



Dr Bhupendra Chaudhary is a Professor of Plant Genetics and Biotechnology at Gautam Buddha University. He is a noted researcher whose current research interests lie in the evolutionary genetics of cotton fiber development which encompass molecular and genome evolution, phylogenetics, and functional characterization of key gene families evolved under cotton domestication using transgenic technologies in cotton. Dr Chaudhary completed his M.Sc.(Hons.) and PhD. from the University of Delhi in 1999 and 2006, respectively. Chaudhary was a Postdoctoral and University Research Fellow at Iowa State University, USA from 2007-08. He has published more than forty research papers in the national and international peer reviewed journals. Dr Chaudhary is a keen student of social science policy particularly related to the field of agriculture.

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