**Cold stress response in *Arabidopsis thaliana* is mediated by GNOM ARF-GEF**

Mohammad Arif Ashraf, Abidur Rahman*

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Temperature is one of the fundamental factors from the beginning of the earth and facilitator of early chemical and enzymatic reactions to create the complex form of life. As a matter of fact, every living organism invariably has the temperature sensing capacity to act and react to the corresponding environmental cues. Unfortunately, in the age of global warming, variability of the temperature around the globe all the year round has put our existence in danger. Most importantly, the change in temperature is causing a great deal of agricultural loss. As a sessile organism, plants are incapable of moving or running away from the inconvenient temperature.

Unlike fight or flight mechanism in human, plants use the hormone to sense their surrounding factors such as light, water, gravity and so on. And, these factors are sensed by master regulator and one of the major phytohormone, auxin, discovered by Charles Darwin more than a century ago. Abidur lab is the pioneer on finding the auxin response in plants during temperature change. Shibasaki et al. (2009) earlier showed that low temperature alters auxin homeostasis in the root of model plant Arabidopsis thaliana. They have demonstrated that under low temperature stress (40C), the trafficking of auxin transporter, PIN FORMED 2 (PIN2), is inhibited, which leads to increased auxin and eventually root growth inhibition. This seminal work has opened the new era of auxin-mediated low temperature sensing mechanism.

In a continuation of this discovery, Ashraf and Rahman (2019) went further to explore the cellular mechanism of auxin response. They have found that one of the proteins from the recycling endosome, GNOM, responds to low temperature stress. GNOM encodes guanine nucleotide exchange factors for ADP ribosylation factor (ARF GEF) and activates vesicle for endocytosis. Interestingly, PIN2 trafficking in the recycling endosome is mediated by GNOM.

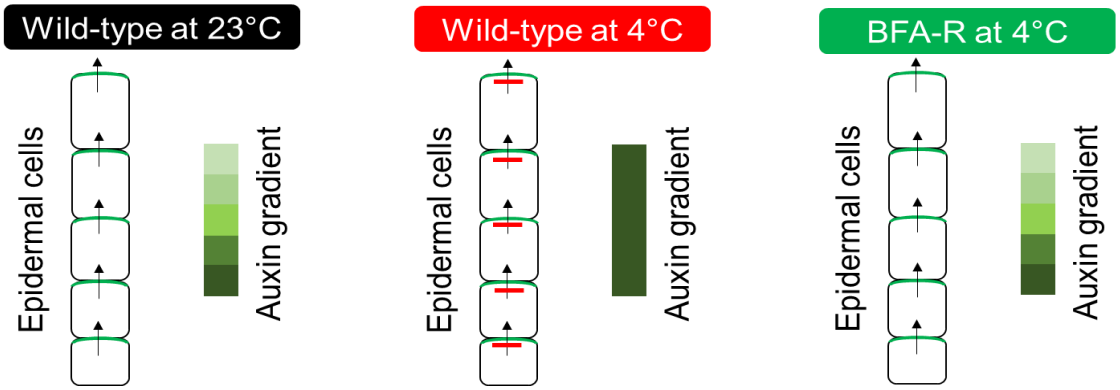


Figure 1: Auxin response in wild-type and BFA-resistant line under normal and cold stress.

Ashraf and Rahman (2019) showed that mutation in the SEC7 domain, gnomB/E, results in low temperature sensitive plant and a point mutation in the SEC7 domain, known as GNOM-engineered BFA resistant line, causes overexpression of GNOM and helps the root growth during low temperature stress. Evolutionary, SEC7 domain is conserved among kingdoms and reported for the temperature sensitive response in yeast. This study fundamentally discovered the evolutionary conserved temperature sensing mechanism in plants.

Authors showed that in the cold-tolerant BFA-resistant line, PIN2 endocytosis persists and keep transporting auxin to maintain auxin homeostasis and this is how the root can maintain the growth even after cold stress (Figure 1). Furthermore, GNOM is expressed in every other part, not only root, of plants. As a result, GNOM overexpressing line, known as GNOM-engineered BFA-resistant line, has better growth dynamics under prolong cold stress exposure (Figure 2). The sequence conservancy of GNOM between model plant Arabidopsis and crop plants such as tomato, rice, wheat holds huge potentiality to engineer the cold tolerant crop varieties in near future.

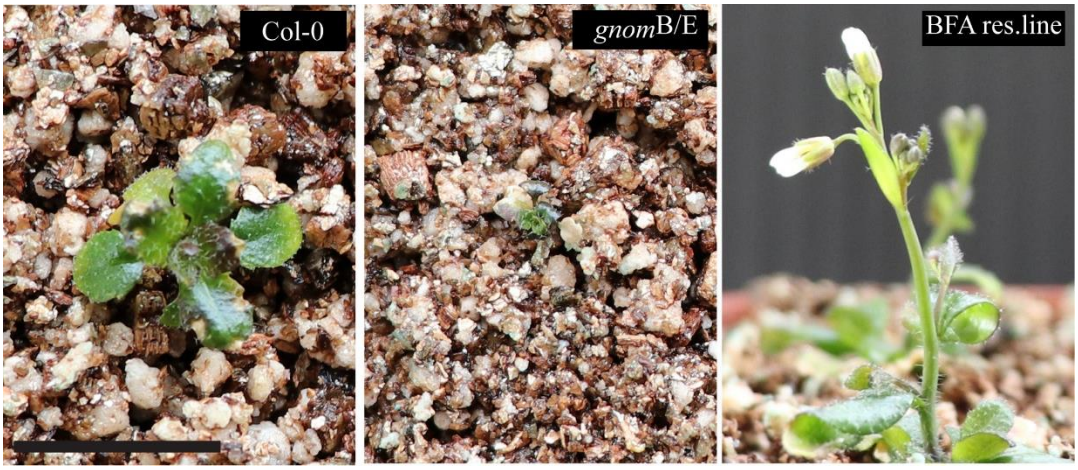


Figure 2: Phenotype of 7-week-old Col-0, BFA res. line and *gnom*$^{B/E}$ plant on soil at 4°C under continuous light condition. (scale bar: 1 cm).