1. 25%

In the absence of fixed nitrogen, some filamentous cyanobacteria differentiate heterocysts, specialized cells devoted to fixing atmospheric nitrogen (N_2). This differentiation process is controlled by the global nitrogen regulator NtcA and involves extensive metabolic reprogramming, including shutdown of photosynthetic CO_2 fixation in heterocysts, to provide a microaerobic environment suitable for N_2 fixation. Small regulatory RNAs (sRNAs) are major post-transcriptional regulators of gene expression in bacteria. In cyanobacteria, responding to nitrogen deficiency involves transcribing several nitrogen-regulated sRNAs. Here, we describe the participation of nitrogen stress-inducible RNA 4 (NsiR4) in post-transcriptionally regulating the expression of two genes involved in CO_2 fixation via the Calvin cycle: *glpX*, which encodes bifunctional sedoheptulose-1,7-bisphosphatase/fructose-1,6-bisphosphatase (SBPase), and *pgk*, which encodes phosphoglycerate kinase (PGK). Using a heterologous reporter assay in *Escherichia coli*, we show that NsiR4 interacts with the 5′-untranslated region (5′-UTR) of *glpX* and *pgk* mRNAs. Overexpressing NsiR4 in *Nostoc* sp. PCC 7120 resulted in a reduced amount of SBPase protein and reduced PGK activity, as well as reduced levels of both *glpX* and *pgk* mRNAs, further supporting that NsiR4 negatively regulates these two enzymes. In addition, using a *gfp* fusion to the *nsiR4* promoter, we show stronger expression of NsiR4 in heterocysts than in vegetative cells, which could contribute to the heterocyst-specific shutdown of Calvin cycle flux. Post-transcriptional regulation of two Calvin cycle enzymes by NsiR4, a nitrogen-regulated sRNA, represents an additional link between nitrogen control and CO_2 assimilation. (Plant Physiology (2021) 187: 787–798.)

1)給此研究下一個英文標題? (英文)
2)以下除了專有名詞外，需用中文敘述
　a)這篇摘要敘述此研究在研究什麼樣的問題?
　b)此研究用了哪些研究方法，這些研究得到什麼樣的結論?
　c)此研究最主要的結論是什麼?

2. 25%

Abscisic acid (ABA) transport plays a crucial role in seed germination under unfavourable conditions such as cold stress. Both heat shock protein 70 (HSP70) and voltage-dependent anion channel (VDAC) protein are involved in cold stress responses in *Arabidopsis*. However, their roles in seed germination with regard to ABA signaling remain unknown. Here we demonstrated that *Arabidopsis HSP70-16* and *VDAC3* jointly suppress seed germination under cold stress conditions. At

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4°C, both *HSP70-16* and *VDAC3* facilitated the efflux of ABA from the endosperm to the embryo and thus inhibited seed germination. HSP70-16 interacted with VDAC3 on the plasma membrane and in the nucleus, and the interplay between HSP70-16 and VDAC3 activated the opening of the VDAC3 ion channel. Our work established a novel function of *HSP70-16* in seed germination under cold stress and a possible association of VDAC3 activity with ABA transportation from endosperm to embryo under cold stress conditions. This study reveals that HSP70-16 interacts with VDAC3 and facilitates the opening of the VDAC3 ion channel, which influences ABA efflux from endosperm to embryo, thus negatively regulates seed germination under cold stress. (Plant, cell and Environment (2021) 44:3616–3627)

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3. 25%

Chloride (Cl^-), traditionally considered harmful for agriculture, has recently been defined as a beneficial macronutrient with specific roles that result in more efficient use of water (WUE), nitrogen (NUE), and CO_2 in well-watered plants. When supplied in a beneficial range of 1–5 mM, Cl^- increases leaf cell size, improves leaf osmoregulation, and reduces water consumption without impairing photosynthetic efficiency, resulting in overall higher WUE. Thus, adequate management of Cl^- nutrition arises as a potential strategy to increase the ability of plants to withstand water deficit. To study the relationship between Cl^- nutrition and drought resistance, tobacco plants treated with 0.5–5 mM Cl^- salts were subjected to sustained water deficit (WD; 60% field capacity) and water deprivation/rehydration treatments, in comparison with plants treated with equivalent concentrations of nitrate, sulfate, and phosphate salts. The results showed that Cl^- application reduced stress symptoms and improved plant growth during water deficit. Drought resistance promoted by Cl^- nutrition resulted from the simultaneous occurrence of water deficit avoidance and tolerance mechanisms, which improved leaf turgor, water balance, photosynthesis performance, and WUE. Thus, it is proposed that beneficial Cl^- levels increase the ability of crops to withstand drought, promoting a more sustainable and resilient agriculture. (Journal of Experimental Botany (2021) 72:5246–5261)

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4. 25%

Anthocyanin pigments contribute to plant coloration and are valuable sources of antioxidants in the human diet as components of fruits and vegetables. Their production is known to be induced by light in apple fruit (*Malus domestica*); however, the underlying molecular mechanism responsible for early-stage light-induced anthocyanin biosynthesis remains unclear. Here, we identified an ethylene response factor (ERF) protein, ERF109, involved in light-induced anthocyanin biosynthesis and found that it promotes coloration by directly binding to anthocyanin-related gene promoters. *Promoter::β-glucuronidase* reporter analysis and Hi-C sequencing showed that a long noncoding RNA, MdLNC499, located nearby *MdERF109*, induces the expression of *MdERF109*. A W-box *cis*-element in the *MdLNC499* promoter was found to be regulated by a transcription factor, MdWRKY1. Transient expression in apple fruit and stable transformation of apple calli allowed us to reconstruct a MdWRKY1–MdLNC499–MdERF109 transcriptional cascade in which MdWRKY1 is activated by light to increase the transcription of *MdLNC499*, which in turn induces *MdERF109*. The MdERF109 protein induces the expression of anthocyanin-related genes and the accumulation of anthocyanins in the early stages of apple coloration. Our results provide a platform for better understanding the various regulatory mechanisms involved in light-induced apple fruit coloration. (The Plant Cell (2021) 33:3309-3330.)

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