Researchers examine mechanism determining plant height and leaf and seed size

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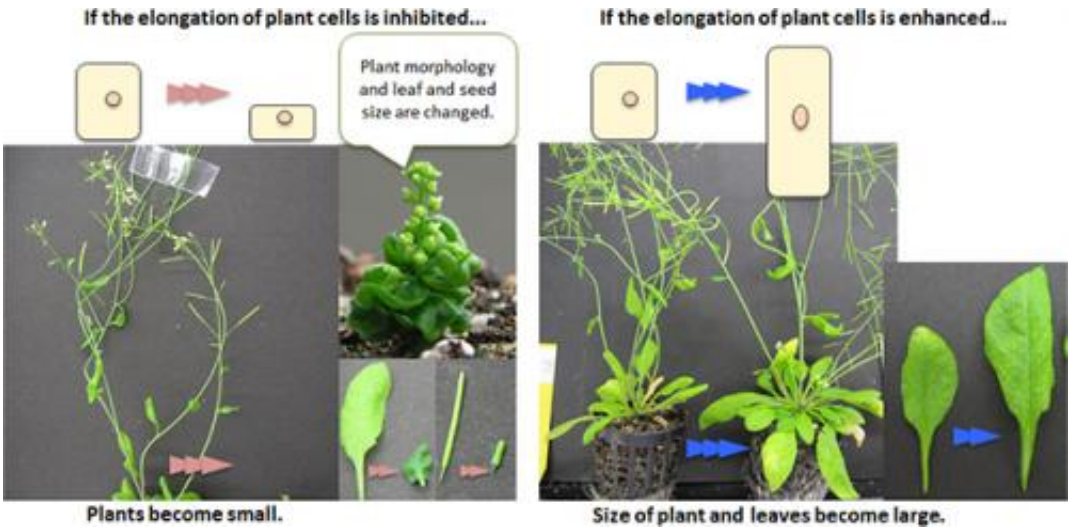

Effect of differences in cell length on plants (Arabidopsis thaliana).

Japanese researchers from the National Institute of Advanced Industrial Science and Technology (AIST) have confirmed that the length of a plant cell is controlled by the antagonistic actions of three types of protein.

Cell length directly affects plant height and leaf and seed size. The researchers have identified two proteins, PRE1 and ACE, which act as a positive regulator for cell elongation, and one protein, AtIBH1, which

inhibits cell elongation. They have found that ACE directly induces cell elongation, whereas AtIBH1 inhibits the activity of ACE by interacting with it. PRE1 indirectly promotes elongation by interfering the activity of AtIBH1. Final cell length is determined by the balance between the three proteins.

These proteins are transcription factors controlling functions of several genes. Use of these transcription factors would make it possible to modify plant height, leaf and seed size, flower and plant morphology, etc. They are expected to be applicable to a variety of areas, including improvement in the efficiency of farming, creation of large plants suitable for biofuel production, and development of unique garden plants.

Details of the results will be published in a US scientific journal, *The Plant Cell*.

Plants, which are important resources, have been traditionally used as food, clothing, and home-building materials, and have comforted people as garden plants. Recently plant-based pharmaceuticals, biofuels, and industrial materials become popular and their application has been increasing. Modifying plant morphology and size to suit different applications should increase the efficiency of production.

From this perspective, modification of plant-cell length is an important subject of breeding studies because it directly affects tree and plant height and leaf and seed size. There are various environmental factors that determine cell length, including sun exposure, temperature, water contents, and nutrient ratios. It is not known how a plant determines its cell length in response to these environmental conditions.

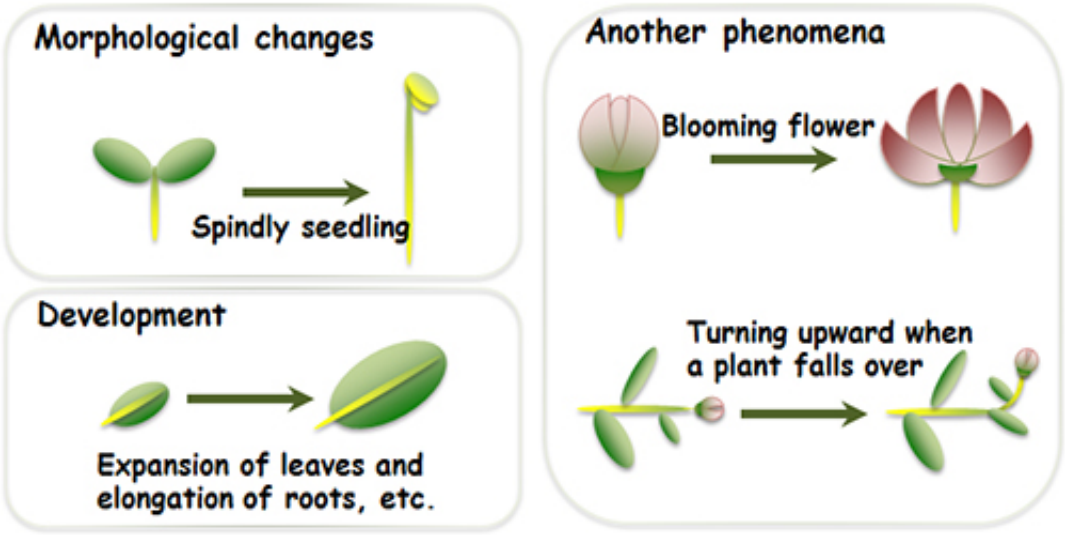

Figure 1: Examples of phenomena in which plant cell elongation is involved.

AIST has been studying plant genes, particularly the transcription factors that control the actions of many genes, in order to apply them to the production of industrial materials, medicines, and food. The Chimeric REpressor Gene Silencing Technology (CRES-T) and the transcription factor library developed in these studies are being used worldwide as general-purpose tools for a variety of basic and applied transcription factor studies. In addition to the development of such general-purpose tools, AIST is also studying functions of individual transcription factors involved in various phenomena, such as plant morphology, size, and substance production. In the present study, the researchers investigated the mechanism by which plant-cell elongation is controlled.

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Plants control cell elongation in response to various environmental

conditions, such as sun exposure, temperature, water, and nutrient ratios, and to grow into forms adapted to their environment (e.g. a sunny or a shady location). When, and which, cells are to be elongated is related to seasonal differences in growth (e.g. the elongation of shoots in spring) and to changes in growth over time (e.g. young plants grow vigorously, whereas old plants grow very little). In addition, plant-cell elongation is involved not only in simple growth but also in important plant functions, such as the blooming of a flower and the turning of a flower toward the light when a plant falls over (Fig. 1).

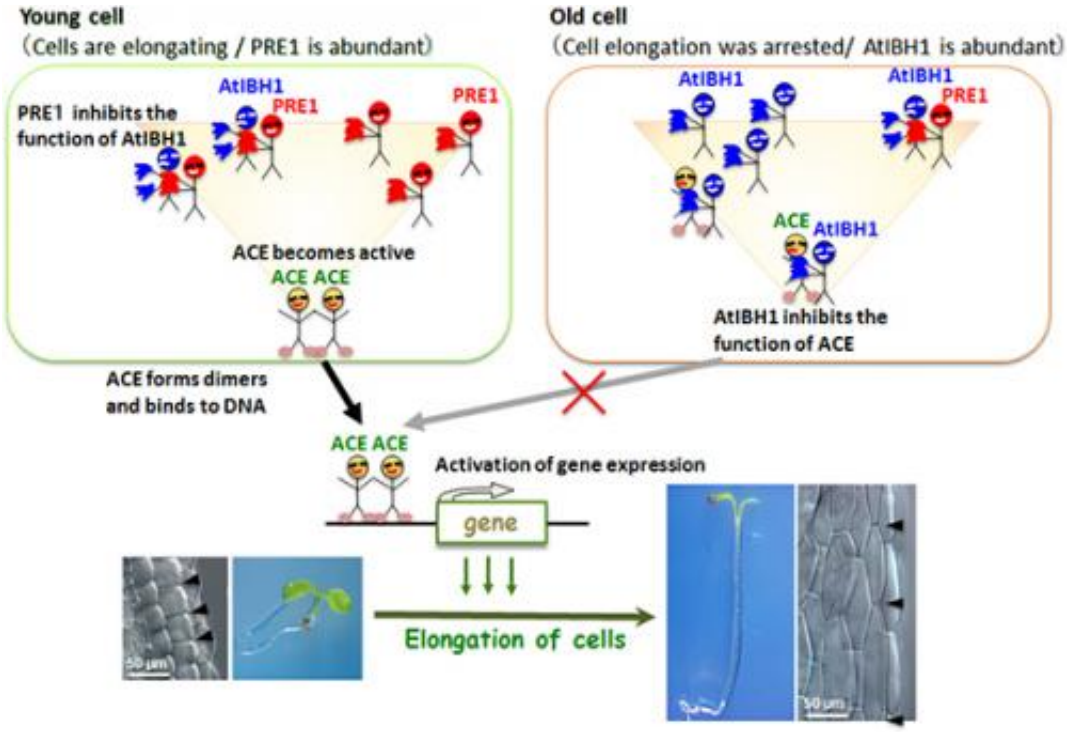

Figure 2: Tri-antagonistic bHLH system controlling plant-cell elongation.

The researchers have identified three transcription factors from a model plant, Arabidopsis thaliana: PRE1 and ACE, which enhance cell elongation, and AtIBH1, which inhibits cell elongation. These three

transcription factors control plant size by regulating cell elongation, without affecting the number of cells. ACE activates the expression of enzyme genes that promote cell elongation. AtIBH1 inhibits cell elongation by interacting with ACE and interfering with its function. PRE1 interacts with AtIBH1 and thus interferes with its inhibition of ACE, thus promoting cell elongation. The researchers named the mechanism of this antagonistic inhibition by ACE, AtIBH1, and PRE1 a tri-antagonistic bHLH system (Fig. 2). Similar mechanisms of antagonistic inhibition, but between only two factors, have been reported in human beings, but mechanisms of antagonistic inhibition by three factors have not been reported before in plants or animals. The tri-antagonistic system is thus a new control mechanism.

Of the three types of transcription factor that were discovered, PRE1 was abundant in stem tips and young leaves and seeds, whereas AtIBH1 was abundant in hardened stem bases, old leaves, and mature seeds. This suggests that the antagonistic inhibition by the three factors, ACE, AtIBH1, and PRE1, regulates the elongation of various cells in each growth stage of the plant.

The researchers aim to develop a technology for modifying plant height and leaf, flower, and seed size by partially enhancing or inhibiting with the functions of PRE1, AtIBH1, and ACE. They will then apply the technology to crop breeding. It is expect that manipulation of these three factors will change plant morphology, as well as its metabolism. They intend to conduct research in the effect of these factors on the metabolic system of plants.

Provided by Advanced Industrial Science and Technology

https://phys.org/news/2013-05-mechanism-height-leaf-seed-size.html