# 5-11 Drastically Altering the DNA of Plants

## —Ion Beams near the Range End Frequently Induce Large Deletions—

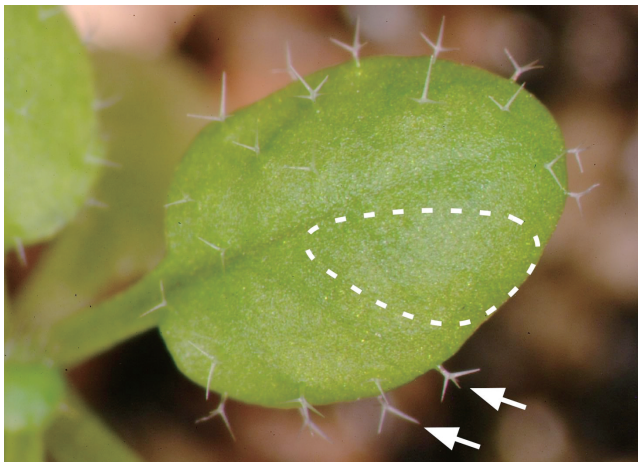

**Fig.5-23 Detection of mutations by utilizing trichomes**
*Arabidopsis* has many trichomes (hairs) on the leaf surface (arrows). Mutation of the *GL1* gene, which is indispensable for trichome development, can be visually detected, because leaf tissue with a mutated *GL1* gene is glabrous (area encircled with the dotted line).

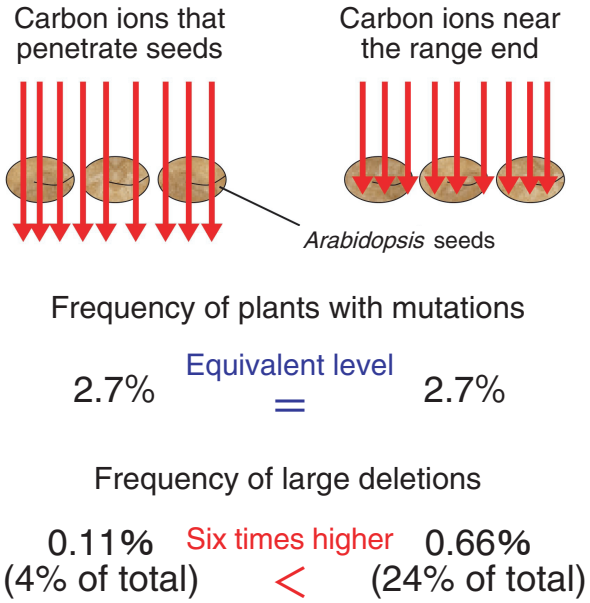


**Fig.5-24 Carbon ions near the range end frequently induce large deletions**
Two types of carbon ion beams with different energies were used to irradiate *Arabidopsis* seeds to compare their mutagenic effects. While the overall frequencies of the mutations were equivalent, the carbon ions near the range end induced large deletions at a frequency six times higher than that of the second type.

Accelerated ion beams have been used as useful mutagens for plant breeding, because they induce mutations different from those induced by $\gamma$-rays or chemical mutagens. For plant breeding, ion beams that penetrate seeds or cultured tissue are typically used. While the ion beams deposit most of their energy close to the end of their range, the types of mutations that are induced by ion beams near their range end have not been studied. Thus, we established an experimental method that enables efficient detection of mutations in plants and examined the characteristics of the mutations induced by ion beams near the range end, with an emphasis on large deletions.

Many trichomes (hairs) can be seen on *Arabidopsis* leaves. The *GLABRA1 (GL1)* gene is indispensable for trichome development. *Arabidopsis* plants that have a mutation of the *GL1* gene in either one of a pair of chromosomes generate glabrous leaf tissue when the other *GL1* gene is mutated (Fig.5-23). This change enables visual detection of the induced mutations and analysis of the characteristics of the mutations induced in the *GL1* gene using DNA isolated from the glabrous leaf tissue.

*Arabidopsis* seeds were irradiated with two types of carbon ion beams: carbon ions that penetrate seeds, and carbon ions near the range end. The frequency of plants with mutated leaf tissue was equivalent for both types of carbon ions at doses that had the same effect on survival reduction. However, the ratio of large deletions among all of the mutations was six times greater for the carbon ions near the range end (Fig.5-24). This result suggests for the first time that ion beams near the range end frequently induce large deletions. Thus, ion beams near the range end are expected to be effective for drastic alteration of DNA to create useful mutations for plant breeding.

**Reference**

Hase, Y. et al., Mutagenic Effects of Carbon Ions near the Range End in Plants, Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis, vol.731, issues 1-2, 2012, p.41-47.