Comprehensive effects of heavy-ion beam irradiation on sweet potato (*Ipomoea batatas* [L.] Lam.)†

H. Park,[*1] Y. Narasako,[*2] T. Abe,[*3] H. Kunitake,[*4] and T. Hirano[*3,*4]

Sweet potato is one of the most important food crops and plays a critical role in food supply and safety worldwide. Although the main feature of sweet potato is the formation of tuberous roots, the detailed mechanisms of how tuberous root formation is controlled by the factors are still unknown. Therefore, an advanced strategy is required for the investigation of molecular functions. Heavy-ion beam has been applied for mutation breeding in various plants and genetic studies.[1,2] In this study, Ar- and C-ion beam irradiation was applied to *in vitro* cultured shoots of sweet potato, and mutant lines were established to screen the mutants on tuberous root formation.

In vitro cultured shoots with an axillary bud of sweet potato (*Ipomoea batatas* 'Beniharuka') were irradiated with $^{12}C^{6+}$ ions (LET; 30 keV μm^{-1}) at absorbed doses of 5.0, 10.0, and 20.0 Gy, or $^{40}Ar^{17+}$ ions (LET; 184 keV μm^{-1}) at absorbed doses of 1.0, 2.5, and 5.0 Gy. The regenerated shoot was cut into nodes, each with an axillary bud, after three months of culture. Three lines were separated from each irradiated shoot. The irradiated lines were acclimatized in the greenhouse and then cultivated in the field.

The shoot formation was decreased at high-dose irradiation of both ion beams. Shoulder doses on the shoot formation curve were considered 10 Gy for the C-ion beam and 2.5 Gy for the Ar-ion beam. We have obtained 335 lines, which consist of 104 and 231 lines derived from Ar- and C-ion irradiation, respectively. After the acclimatization, 116 and 211 irradiated lines survived and were used for the mutant screening in the fields in 2020 and 2021, respectively. The irradiated lines demonstrated a wide range of phenotype variations in the tuberous roots (Fig. 1). Generally, the total weight of the tuberous roots tends to decrease in the C- and Ar-ion irradiated lines. The high-yield lines, with an increase of more than 180%, were derived from Ar-ion irradiation. Considerable inhibition of tuberous root formation was observed in the lines derived from C- and Ar-ion irradiation. It was indicated that heavy-ion beam mutagenesis is effective in broadening the range of the phenotypes corresponding to tuberous root formation. These mutant candidates are expected to enhance our understanding of the mechanisms related to tuberous root formation.

References

1) T. Abe *et al.*, Nucl. Phys. News **25**, 30 (2015).
2) T. Hirano *et al.*, Cytologia **87**, 3 (2022).

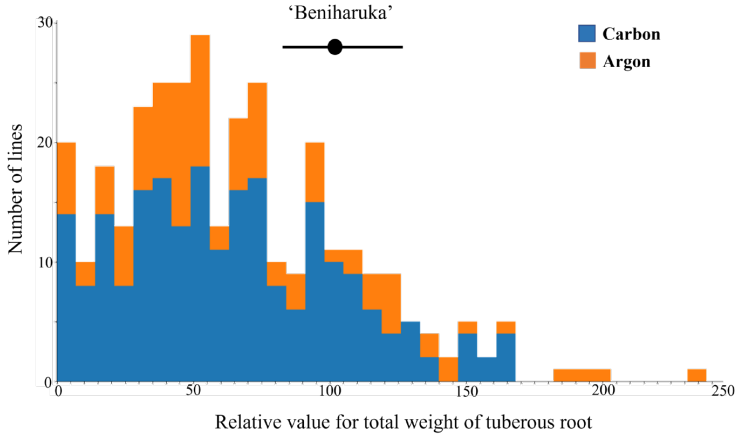

Fig. 1. Frequency distribution of the relative total weight of tuberous roots in C- and Ar-ion irradiated lines. The data represents the combined results for 2020 and 2021. The circle and bar represent the mean (100) and range of 'Beniharuka,' respectively.

† Condensed from the article in Plant Biotechnol. **39**, 311 (2022)

*1 Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki
*2 Kushima AoiFarm Co.
*3 RIKEN Nishina Center
*4 Faculty of Agriculture, University of Miyazaki