Effects of Ar-ion beam irradiation on inducing mutations in chrysanthemum and sweetpotato

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It is expected that heavy-ion beam irradiation will be useful in inducing mutations for plant breeding in agriculture[1), 2)]. However, effects of Ar-ion beam irradiation on many plant species remain unexplained. Therefore, effects of Ar-ion beam irradiation on chrysanthemum and sweetpotato, which are major crops in Kagoshima Prefecture, was investigated and compared with C-ion beams in this study.

At first, we investigated effects of Ar-ion beam irradiation on regeneration of chrysanthemum. Leaf blades of the spray-mum cultivar "Southern Chelsea", which was developed in Kagoshima Prefecture, were irradiated by Ar-ion beams (LET: 280 keV/μm) at doses of 0.1, 0.3, 0.5, 1, 2, and 3 Gy, and C-ion beams (LET: 23 keV/μm) at doses of 1, 2, and 3 Gy. After irradiation, these tissues were cultured in vitro, and the number of directly regenerated plants from adventitious shoots[1)] were counted. The relative regeneration rates of Ar ions were lower than that of C ions at the same dose, and the proportion between relative regeneration rates of Ar ions and C ions (Ar/C) became lower according to increasing of irradiation doses (Fig. 1). In addition, the relative regeneration rate of Ar ions became higher according to decreasing of irradiation doses; 37.8%, 65.9%, and 90.9% at doses of 1, 0.5, and 0.3 Gy, respectively (Fig. 1). From past findings, the optimal dose for inducing mutations in chrysanthemum will be at the dose when the relative regeneration rate has declined considerably, and this optimal dose of C ions will be 2 Gy[3)]. Consequently, the optimal dose of Ar ions is estimated to be 0.5 Gy assuming that the relative regeneration rate of Ar ions for optimal dose is at the same level with C ions.

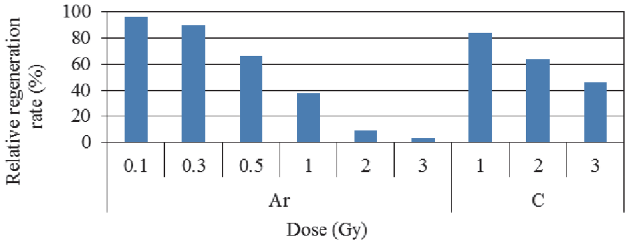

Fig. 1. Comparison of the relative regeneration rate by the Ar-ion and C-ion beam irradiation in "Southern Chelsea". The relative regeneration rate means the rate of regenerated shoots after ion beam irradiation to radiationless regenerated shoots, which were directly developed from adventitious shoots[1)].

Next, we investigated the effects of Ar-ion beam irradiation on inducing mutations for sweetpotato. Axillary shoots of in vitro-grown stems of cultivar "Konamizuki" were irradiated by Ar-ion beams (LET: 280 keV/μm) at doses of 1, 2, and 3 Gy, and C-ion beams (LET: 23 keV/μm) at doses of 10 and 15 Gy. After irradiation, these tissues were cultured for about 10 weeks, and the growth and morphological mutations of in vitro plants were observed. In Fig. 2, mortality rate, stunting rate, and mutation rate mean the rate of samples that died without germination, samples whose stem lengths were less than 2 cm, and samples whose leaves have one or more incisions, respectively, to investigated samples. The original leaf of cultivar "Konamizuki" is cordate. Under the experimental condition used in this study, the mortality rates of both Ar ions and C ions were relatively low (Fig. 2) . In contrast, the stunting rate at 3 Gy Ar ions was about 4.7 times and about 1.8 times higher than those at 10 Gy and 15 Gy C ions, respectively (Fig. 2). This fact suggests that the dose of Ar ions that strongly influences the growth of sweetpotato will be lower than that of C ions. Furthermore, the morphological mutation rate at 2 Gy Ar ions was 25.7% (Fig. 2). This rate was highest under all irradiation conditions. Because many morphological mutations can be detected at the mature stage, the reason that the mutation rate at 2 Gy Ar ions is higer than that at 3 Gy Ar ions could be the high stunting rate at 3 Gy Ar ions. Moreover, some of the mutations leading to the incision of leaves were the results of spontaneous mutation; however, the mutation rate under heavy-ion beam irradiation was clearly higher than that observed under non-irradiation. These morphological mutants are chimera plants generated from multicellular tissues. Therefore, we tried to separate mutation sites by cutting out mutation tissues. On the basis of these results, it is supposed that a low dose of Ar-ion beams strongly affects on the growth and morphological mutation of sweetpotato.

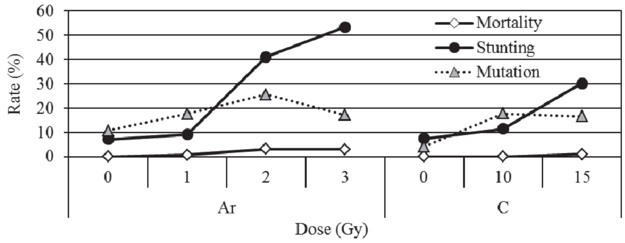

Fig. 2. Effects of heavy-ion beam irradiation on sweetpotato cultivar "Konamizuki". The period and times of irradiation and the number of samples (from 96 to 187) were different based on the line class and doses.

References

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