Relationship between early-flowering mutation and LET-Gy combination of ion beam irradiation in durum wheat

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Durum wheat (*Triticum turgidum* ssp. *durum*) is a tetraploid species with the genome constitution AABB derived from two wild diploid ancestral species: the A genome from *T. urartu* and the B genome from *Aegilops speltoides* or another species classified in the Sitopsis section. Therefore, the tetraploid durum wheat genome contains duplicated homoeologous genes, and this characteristic may increase the difficulty of screening for mutants in durum wheat. To avoid this problem, we have chosen the use of cultivated diploid einkorn wheat (*T. monococcum*) with the A^m genome, similar to the A genome in bread wheat, for developing a large-scale mutant panel.[1)] and screened and analyzed several mutants from the mutant panel.[2)] However, durum wheat is an important crop species for making pasta, and we have started to make a mutant panel of durum wheat by heavy-ion beam irradiation.

To avoid the rainy season for harvesting, early maturing is one of the important properties of bread wheat in East Asia, including Japan. Therefore, we focused on identifying early-flowering mutations in the screening of the mutant panel.

Dry seeds of the durum wheat cultivar "Langdon" were irradiated with 15, 30, or 50 Gy of $^{12}C^{6+}$ ions at LET values of 30, 50, or 70 keV μm^{-1}, or 2.5, 5.0, 7.5, 10, or 20 Gy of $^{40}Ar^{17+}$ ions (290 keV μm^{-1}) to determine the optimal conditions for mutant generation by using the E5 beam line of the Ring Cyclotron (RRC) in the RIKEN RI-beam factory. The M_1 seedlings were planted in the field in October 2014. The viability rate for the Ar ion beam was reduced to less than 60% with a dose greater than 7.5 Gy, and all plants died when the dose was 10 or 20 Gy. The harvested seeds from each individual M_1 plant were used to produce the next generation (M_2) lines. 77–134 M_2 lines (1068 lines in total) for each LET-Gy combination were sown in October 2015 in the fields; ten seeds of each M_2 line were sown. The frequency of lines with albino plant(s) among the ten plants was determined to assess the comparative mutation ratio of the different irradiation conditions. The frequency of albino plants in the M_2 generation was different for different LET-Gy combinations (data not shown). The highest ratio (>2.0%) was observed for the LET50-30Gy treatment condition. On the other hand, the data of survival ratio suggests that LET70-15Gy treatment was the optimal condition for durum wheat.[3)]

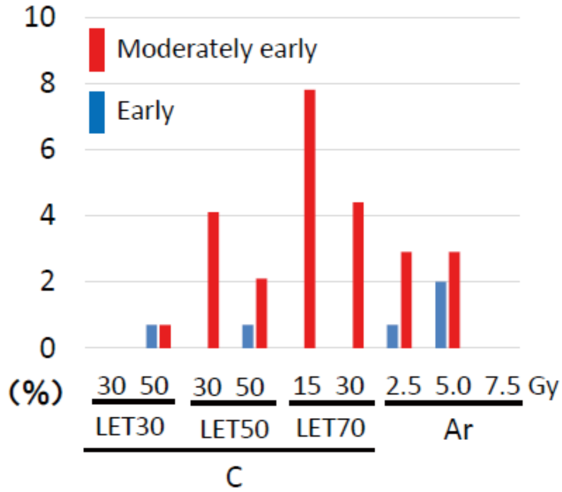

Fig. 1. Appearance of early-flowering mutant plants in M_2 generation. Percentages (%) of M_2 lines segregating mutant plants are shown in each LET-Gy combination of ion-beam irradiation. Red and blue bars indicate moderately early-flowering and early-flowering mutants, respectively.

In the mutant screening in 2016, we observed moderately early-flowering mutation within a few days and early-flowering mutation before four days, compared with the wild-type. Figure 1 shows the percentages of the M_2 lines segregating early-flowering mutant(s). The moderately early-flowering mutants were obtained under relatively moderate treatment condition of LET70-15Gy with C, whereas early-flowering mutants were mainly obtained under harsher treatment condition of 5.0 Gy with Ar.

Durum wheat cultivars are usually late-heading and not suitable for cultivation in Japan, because we have a rainy season from June to July. All known cultivars of durum wheat show pre-harvest sprouting when subjected to prolonged rainfall before harvest. Furthermore, durum wheat cultivars are susceptible to the Fusarium head blight disease. To develop durum wheat cultivars suitable for wide cultivation in Japan, we are focusing on identifying mutations of early-heading, short culm, and resistance against pre-harvest sprouting and Fusarium head blight in durum wheat by using heavy-ion beam mutagenesis.

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References

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