Effect of heavy ion beam irradiation on germination and mutation rate in local Toraja rice

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Tana Toraja is one of the areas in South Sulawesi that has wide local rice germplasm diversity. Based on the results of a survey of local rice in the Tana Toraja district, Suhardi *et al.* found approximately 29 local varieties of Toraja rice, each of which has exotic characteristics such as brown rice, red, aromatic and glutinous.[1)] The local rice cultivars have many unique traits, for example black and red rice. These colored rice cultivars are in the spotlight as food with health-promoting benefits because these pigments found in them have an antioxidative effect.[2)] However, improved rice cultivars are expanded in this area. Most farmers grow no native rice cultivar because the yield of these cultivars is lower than the improved cultivars and have long maturity during 5–6 months (Fig. 1). It is feared this will result in a lack of local rice cultivars as germplasm materials. Our research aims to improve the productivity of local cultivars with unique trait by heavy-ion beam irradiation. In this study, we evaluated seed germination as a result of irradiation using ion beam in two varieties of Toraja local rice.

Pare Ambo and Pare Lea are black and red rice cultivar (*Oryza sativa* L.) in Tana Toraja, respectively (Fig. 2). Dry seeds packed in a plastic case were irradiated with Ar (309 keV/μm) and C (30 keV/μm) in RI-beam factory, RIKEN Nishina Center, Japan. The doses of Argon-ion and Carbon-ion were 10 and 150 Gy, respectively.[3,4)]

Each grain from one panicle for each M_1 plant was germinated in one line method on a 15 cm Petri dish and transplanted into small plastic bags. The germination percentages of seeds used before being irradiated are 85% and 98% in Pare Ambo and Pare Lea, respectively (Table 1). Ion beam irradiation reduced the germination percentage of Pare Ambo by approximately 30%. However, the germination percentage of Pare Lea after irradiation was approximately the same as before irradiation. M_1 seeds of Pare Ambo and Pare Lea irradiated with Argon-ion produced better seedling growths than Carbon-ion.

Fig. 1. Local red rice "Pare lea" has a long culm tending to lodge.

Fig. 2. Pre Ambo (Black rice) and Pare lea (red rice).

Table 1. Germination rate (%) on M_1 and M_2 seeds in Tana Toraja rice cultivars Pare Ambo and Pare Lea.

Cultivar	Before Irradiation	M_1		M_2	
		Irradiation Ion		Irradiation Ion	
		Carbon	Argon	Carbon	Argon
Pare Ambo	85	54	55	85	90
Pare Lea	98	97	98	93	94

Table 2. Number of plants undergoing albino mutation in Tana Toraja rice cultivars Pare Ambo and Pare Lea.

Ion	Cultivar	M_2 plants (No.)	Albino (No.)	Mutation Rate (%)
Carbon	Pare Ambo	414	8	1.9
	Pare Lea	1619	46	2.8
Argon	Pare Ambo	90	1	1.1
	Pare Lea	1034	22	2.1

Further M_2 seed germination shows uniqueness in some seedlings, such as lighter leaf color, albinism and wrinkled leaf, which could prove to be potential mutant lines in tested M_2 lines seed. Chlorophyll mutation in M_2 plant was observed through the color of the leaves ten days after sowing until the plant was transplanted into the rice field. The irradiation treatment with ion beam also gives rise to chlorophyll mutations as seen in M_2 of Pare Ambo and Pare Lea (Table 2). A higher albino mutation rate was found in M_2 population irradiated by carbon ion instead of argon ion in both cultivars. The occurrence chlorophyll mutation occurring is a mutagenic effect of carbon-ion beam, which indicates that the treatment is effective in the creation of genetic diversity in the M_2 population.

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