

# Rinaldi\_2019\_IOP\_Conf.\_305\_0 12055.pdf

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TIME SUBMITTED	27-JUL-2019 08:00AM (UTC+0700)	WORD COUNT	1756
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## The Effect of Argon and Carbon Ion After Heavy Ion Beam Irradiation of Toraja Local Rice

**Abstract.** Red rice is not popular to be cultivated extensively by farmers because of long harvest period, which takes between 6 to 7 months before harvested. Therefore, there is a need to create a diversity of morphological characters, as the character for selection, especially related to the time of harvest. One method is through breeding mutation by irradiation using ion beam. The aim of this study is to evaluate early maturing lines after irradiation using ion beam in Toraja local rice. The experiment was conducted at Gowa and Enrekang Regency, South Sulawesi using Red local Toraja rice variety (Pare Lea) treated with ion beam irradiation of Argon ion (10 Gy) and Carbon (150 Gy). The result showed that Carbon ion irradiation treatment produced a higher number of mutants than argon ion irradiation at both locations. Secondly, carbon ion has a greater number of frequencies in the criteria of early maturing compared to Argon ion and harvesting day of red rice in the highlands is comparatively still longer than in the lowlands.

### 1. Introduction

The local rice varieties used for generations as part of the tradition and culture are black and red rice of North Toraja regency. The local name of black and red rice paddy in question are Pare Ambo and Pare Lea. Generally, the rice is still cultivated organically. Cultivation technique is simple and not as intensive as cultivation techniques applied to the production of improved rice varieties. The use of black and red rice in rituals help preserve the culture of traditional rice varieties amid the rapid introduction of new cultivated varieties.

Red rice has long been known to be beneficial to health, Brown rice, in addition to being the main source of carbohydrates, also contains protein, beta-carotene, antioxidants and iron [1]. Mashed brown rice contains 7.30% protein, 4.20% iron, and 0.34% vitamin B1. Furthermore, according to Chang and Bardenas (1965) [2], the anthocyanin pigment in brown rice is not only found in rice skin, but can

include all parts of rice such as *O. glaberrima* rice. This anthocyanin pigment acts as an antioxidant, mutagenic, hepatoprotective, antihypertensive and antihyperglycemic in the prevention of several diseases such as cancer, diabetes, cholesterol and coronary heart disease [3]. However, on account of its long life span ranging between 6 to 7 months, black rice and red rice became less developed in a broad scale. In addition, the local rice productivity is still low. In general, local rice production in the country amounted to 3.99 tonnes ha<sup>-1</sup> which is much lower than the productivity of cultivated rice variety by 5.26 ton ha<sup>-1</sup>.

The availability of high-yielding varieties of black rice and red rice with early maturing character and also high nutritional function and high production as well as wide environment adaptivity, will be a challenge in the development of agriculture in this country where we are limited by sub-optimal land and the global effects of climate change, such as: prolonged drought, flooding, acid soil, or the salinity problem. This problem should be an important consideration of the breeding program, including mutation breeding intended for crop improvement. With the development of new technology, breeding techniques are now being developed by using heavy ion beam. Ion beams are novel physical mutagens that have been applied to a wide variety of plant species [4].

This research is expected to create new pigmented rice with early maturity characters. Based on this, research needs to be done about "The Effect of Argon And Carbon Ion After Heavy Ion Beam Irradiation of Toraja Local Rice".

## 2. Method

This research was conducted at Enrekang and Gowa Districts, South Sulawesi. This research takes place from May to October 2017.

### 2.1. Experimental apparatus

Materials used in this study were: local aromatic rice seed *Toraja* generation (Pare Bau) M1 irradiated under carbon ion 150 Gy carbon-ion and 10 Gy argon-ion beams, manure, and soil for nursery media, rat poisons, pesticides, irrigation water, and labels. The tools used in this experiment are: plastic pots for sowing, machetes, hoes, tractors, sprayer, nets, measuring devices, analytical scales, contador seed counters, cameras and stationery.

### 2.2. Problem formulation

The study was conducted by mass selection method consisting of two irradiation treatments, namely: 1) irradiation with a dose of 150 Gy carbon ions (PB-C); 2) irradiation with 10 Gy Argon ion (PB-A), and control as a comparison. This study used M2 aromatic rice from local aromatic rice of the Toraja Pare Bau variety, the results of the Ion Carbon Beam mutation technique and the Argon group for M0 seeds were conducted at RIKEN Nishina Center, Wako, Saitama Prefecture, Japan.

The results of the calculation of plant harvest age on the total population of black and red rice planted were analyzed statistically non parametric by frequency distribution approach. Measurement data on the age of the harvest are then grouped into three criteria class levels, namely plants with early maturity class (<120 hss), medium (120-150 hss) and deep (150 hss).

## 3. Results and Discussions

### 3.1. Mutant Frequency

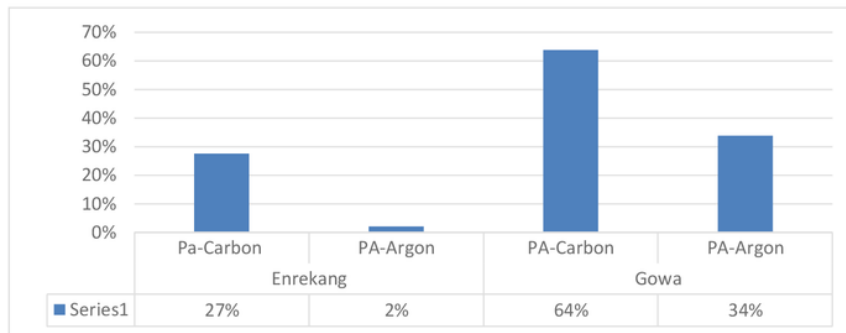


Figure 1. Graph of frequency of black rice mutants at the location of highland (Enrekang) and lowland (Gowa)

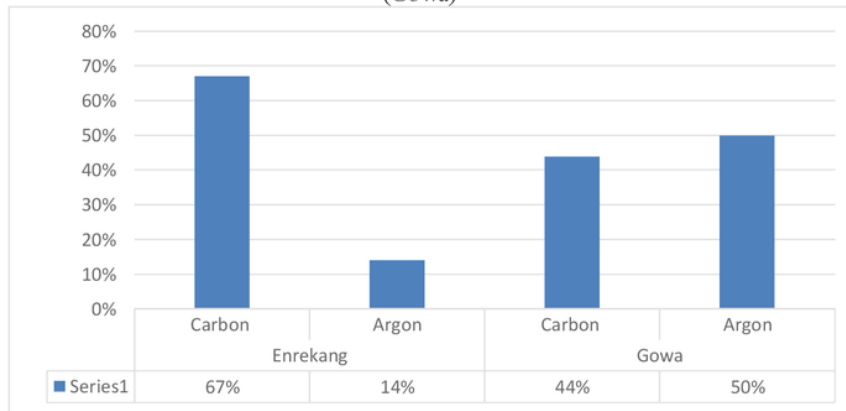


Figure 2. Graph of frequency of red rice mutants at the location of highland (Enrekang) and lowland (Gowa)

The result showed that in the two planting locations showed that the carbon ion irradiation treatment produced a higher number of mutants compared to the argon ion irradiation treatment (Figures 1 and 2). The high number of mutations caused by irradiation of carbon ions is caused because the energy fired by carbon ions is greater, namely 135 MeV / u compared to the energy in the Argon ion which is only 95 MeV / u [5]. This allows the amount of damage to the gene caused by the release of energy from the ions that are fired, so that the diversity (mutants) generated is also increasing. Other advantages of ion beam mutagenesis include high survival rates, high levels of mutation induction and various other variations [6]. In addition, if compared to the location of planting, the percentage of mutants in the lowlands is higher than in the planting location on the highlands.

### 3.2. Harvesting day

The results of observations on harvest age by treatment of ion beam irradiation using Carbon ion and argon ion showed that Carbon ion had a greater number of frequencies in the criteria of early maturing compared to Argon ion. In addition, the results of observations on harvest age at the two planting sites showed a longer harvest age in the highlands than in the lowlands which turned out to be faster (Figures 3 and 4). Mutants with medium age class on carbon ion irradiation treatment as much as 8.7% or 113 lines. Whereas for argon ion irradiation, mutants with medium age class are 21.3% or 23 lines. However, when compared to the location of planting, the percentage of lowland mutants in the

lowlands is higher than in the planting location in the highlands. This is probably due to differences in environmental conditions in both locations, where at the planting location in Gowa district the average air temperature is 27 ° C with 152 mm / month rainfall different from that in Enrekang district which has a lower average air temperature of 23 ° C with 154 mm / month of rainfall during the study.

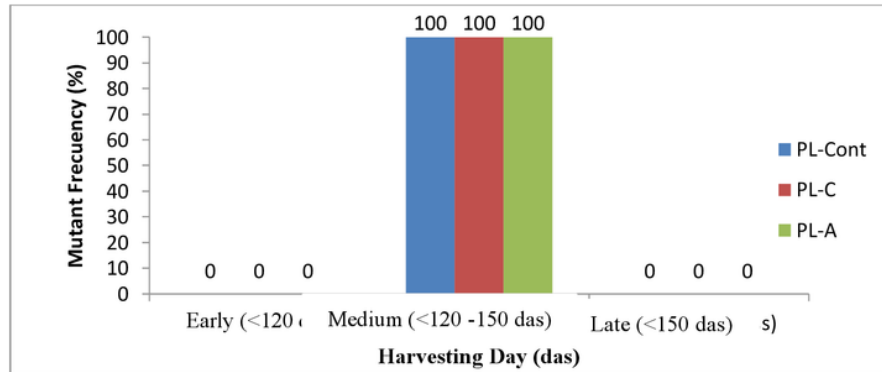


Figure 3. Graph of Red rice mutant frequency on observed parameters of harvest age at the location of land (Lowland)

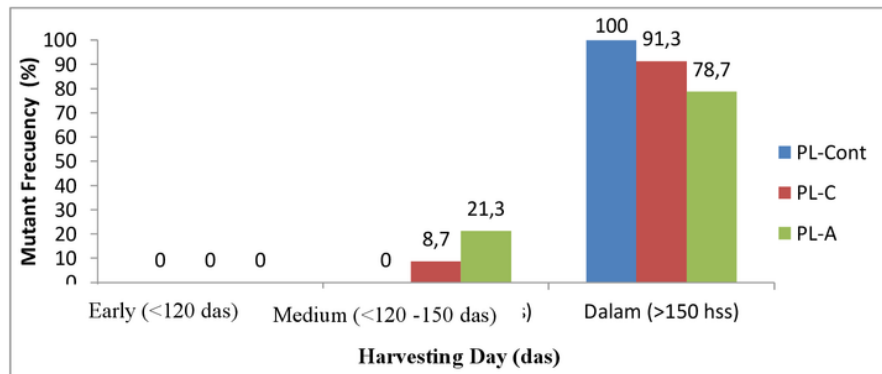


Figure 4. Graph of Red rice mutant frequency on observed parameters of harvest age at the location of medium highland.

Climate elements are one of the environmental components that greatly affect the growth and development of plants, one of which is air temperature. The air temperature influences the phase of plant development, in this case affecting the age of the plant [7, 8]. The effect of the lower air temperature on the high place will make the plant's age grow longer, on the contrary in the area with low age the plant will be shorter.

#### **4. Conclusions**

Based on the results of the research can be summerized that Carbon ion irradiation treatment produced a higher number of mutants than argon ion irradiation at both locations. Secondly, carbon ion has a greater number of frequencies in the criteria of early maturing compared to Argon ion and harvesting day of red rice in the highlands is comparatively still longer than in the lowlands.

#### **Acknowledgments**

This research cannot be accomplished without funding from World Class University (WCU) Hasanuddin University 2016 and RIKEN Nishina Center, Japan for the help of irradiation of seeds.

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