# 3-05 Ion Beam Irradiation with Rice Seeds for the Mutation Breeding Project of the Forum for Nuclear Cooperation in Asia (FNCA)

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## 1. Introduction

For the spread of radiation application and development of ion beam breeding technique, ion beams have been utilized under the Mutation Breeding Project of the Forum for Nuclear Cooperation in Asia (FNCA) of MEXT (Ministry of Education, Culture, Sports, Science and Technology). This project contributes to increase food production and to improve food quality in Asia, by developing new mutant varieties with disease resistance, insect resistance, and drought tolerance of important crops, such as rice, bananas, orchids, sorghum, and soybeans, by using ionizing radiation. As the Sub-Project on Composition or Quality in Rice, utilization of ion beams has been started in 2009. Eight participant countries, i.e., Bangladesh, China, Indonesia, Korea, Malaysia, Philippines, Thailand and Vietnam joined the ion beam irradiation with rice seeds.

## 2. Materials & Methods

In order to obtain fruitful results, the clear and common protocol for all participant countries was firstly drawn up as shown in Fig. 1.

**Outline of Protocol for Ion Beam Breeding of Rice in FNCA**

1. First irradiation for sensitivity test of the sample
   - Rice dry seeds: 0, 10, 20, 40, 60, 80, 100, 120, 160, 200 Gy
   - 150 seeds per test-dose (totally 1,500 seeds)
2. Sensitivity test *
   - Survival & Growth rate (e.g. planted for 3 weeks)
   - 50 seeds for each experiment X3 replications per test-dose
   * follow Hidema's method (JAERI-Review 2003)
3. Determine the best dose:
   - usually at around the shoulder end of survival curve
4. Irradiation for mutagenesis (Second irradiation)
   - basically as many seeds as possible you can desirably more than 5,000 seeds (=M1)
5. Establishment of M2 lines
   - 1-3 M2 seeds per 1 plant (basically followed by one-plant-one-grain method)
   e.g. 3 x 5,000 = 15,000 M2 are tested

Fig. 1 Outline of protocol for the ion beam irradiation.

In general, hulled dry seeds of a rice cultivar (cv.) of participant country was irradiated with 320 MeV carbon ion beams in TIARA. About 70-100 seeds were set on a 50 mm petri-dish and irradiated within 30-90 seconds for any doses ranged from 10 to 200 Gy. After irradiation, seeds were rightly sent back to the participant countries and grown to obtain survival curves and the offspring.

## 3. Results and Discussion

The purpose of rice breeding should be high yield and good quality in term of low amylose content or high protein content and other characters. For this purpose, ion beam irradiation should be effective but not too much, in order not to induce bad characters or abnormalities of a mutant plant. To determine the optimal doses for mutation induction is the first and most important work for mutation breeding. Radiation sensitivity strongly depends on not only sub-species (indica or japonica) but also their cultivars. Therefore, precise data should be necessary for each cultivar. The growth and survival curves have been obtained to evaluate the best dose for mutation induction (Fig. 2). For example, in the case of indica cv. Ashal, proper dose would be 30-40 Gy because these doses caused the shoulder end of the survival curve that would be proper to induce mutants without bad characters from our sufficient experiences. Several countries have already obtained survival curves and identified the optimal doses for mutation induction. The other countries will continue sensitivity tests and determination of the optimal doses for mutagenization.

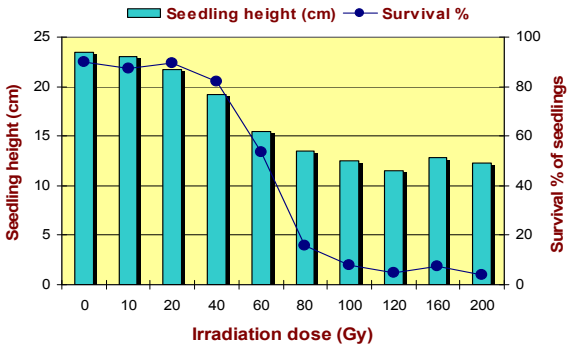


Fig. 2 The growth and survival data of indica cv. Ashal seeds irradiated with carbon ions (courtesy of Dr. Md. Lokman Hakim, Bangladesh).

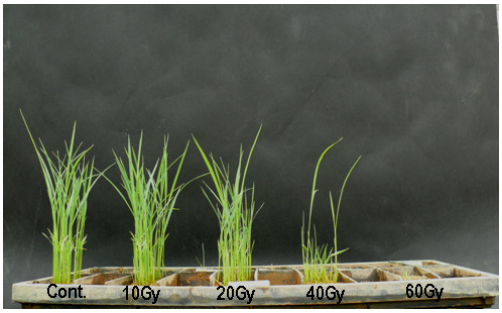


Fig. 3 Three-week-old plant of japonica cv. Ilpum irradiated with carbon ions (courtesy of Dr. Si-Yong Kang, Korea).