

Presentation Summaries of FNCA JFY2022 Workshop on Mutation Breeding Project

February 21st - 23rd, 2023
Bangkok, Thailand and Online

Bangladesh (Dr. A.N.K Mamun, Bangladesh Atomic Energy Commission)

New rice variety BINA dhan-25 is a premium quality (extra long and slender) high yielding, short duration (138-148 days), photo-insensitive boro rice variety registered and released for cultivation in 2022 is developed by carbon ion beam. In grain, the amount of amylose content is 25.1% and protein content is 6.6%. Rice is white, neat and tasty so the market price is high and it is suitable for export. Average yield is 7.6 ton/ha and highest yield is 8.7 ton/ha. Application is made for the official release as a variety namely “Lal Atom dhan 1” using carbon ion beam irradiation of indigenous rice landrace B-11. It was developed through 50 Gy carbon ion beam irradiation under FNCA project at QST, Takasaki, Japan. It is early mature, day neutral, higher yield (7.8 to 8.0 t/ha) with high amylose content (26.6%) Boro rice. It can cultivate relatively low fertilizer and low irrigation system. This variety is being developed with the co-operation of IAEA/RCA, FNCA and Lal Teer Seed Ltd.

China (Prof. Shu Qingyao, Zhejiang University)

Our rice breeding project has been focused on (i) development of new rice mutants with the potential to become new rice varieties, (ii) identification of mutant genes underlying mutated traits, (iii) establishment of protocols for mutant screening, and (iv) promotion of new mutant rice varieties for commercial production. During the past year, various breeding techniques, e.g. mutation induction, anther culture, genome editing, molecular marker assisted selection, have been deployed for the development of conventional and hybrid rice varieties as well as generating elite breeding lines.

The main achievement of the past year includes the following: (1) An artificial inoculation system for bakanae disease infection was developed and putative resistant mutant lines were identified; (2) An ABA-serotonin module regulating root suberization and salt tolerance was discovered; (3) The genetic mechanism underpinning the suppression of xantha leaf trait was uncovered in rice; (4) A system named iMPS was developed for fast identification of induced mutations through NGS of pooled mutant plants and a nonsense mutation of *OsNramp5* was identified; (5) Jiang-liang-you 7901, a nationally registered hybrid rice, with an early maturing mutant as its female line, are being grown in several provinces and showed great promise for further expansion, another hybrid rice ZJU-QJY1610 has been commercialized. (6) Two hybrid rice, ZJU-QJY167 and ZJU-JXY610 were registered at the national level.

Indonesia (Dr. Winda Puspitasari, National Research and Innovation Agency)

One strategy that can be carried out to increase national soybean production is by expanding the planting area, including marginal land that has low fertility, such as acid soil, and by using soybean genotypes that are tolerant to acid soils. This study was conducted to screen acid-soil tolerant genotypes and identify molecular markers suitable for application to mutant lines selection. From the study, it was found that the character of stress tolerance index in the soil-based trial could be used to identify stress tolerant genotypes. In addition, marker of Satt406 was able to identify tolerant and sensitive genotypes to acid soils in soybean. In addition, soybean mutation breeding is also conducted for selection on early maturing characters, resistance to drought stress and high seed quality.

Japan (Dr. Hase Yoshihiro, National Institutes for Quantum Science and Technology)

The molecular nature of mutations induced by ionizing radiation is becoming clearer owing to the availability of high-throughput DNA sequencing technology. However, few studies have compared the induced mutations between different radiation qualities and between different irradiated materials with the same analysis method. In the last five years, we compared the induced mutation between dry seeds and seedlings irradiated with carbon ions and gamma rays in *Arabidopsis*. We also characterized the induced mutation by chronic gamma irradiation. The results provide an overall picture of radiation-induced mutation in *Arabidopsis* and will be useful for selection of a suitable radiation treatment for mutagenesis.

Korea (Prof. Si-Yong Kang, Kongju National University)

It has been suggested that ion beams with high linear energy transfer (LET) and high relative biological effectiveness (RBE) induce higher mutation frequency and spectrum than low LET radiations (gamma and x rays). The KOMAC (Korea Multi-Purpose Accelerator Complex) under the KAERI was constructed in Gyeongju in 2013 and then has been provide 45 MeV and 100 MeV proton beam irradiation service. The KAERI research group started wide researches for setting the irradiation condition of 100 MeV proton beam of the KOMAC for mutation breeding. Two research papers related to proton beam breeding conducted by our research team were published in two international journals in 2021. In 2022, we have been conducted a series of comparative study of proton ion-beam and gamma ray on the *Brassica* family species (i.e *Brassica rapa* subsp *Trilocularis*, rapid cycle brassica) and other crops (kenaf, hops, etc) for application of mutation breeding. Main purpose of this research is to compare the mutation induction rate and genomic information between both radiations by phenotypic variation and to develop useful new varieties and genetic resources with improved traits; good quality and disease resistance.

Malaysia (Dr. Sobri Bin Hussein, Malaysian Nuclear Agency)

In order to further expand the potential of mutant rice and to meet the market demand, Malaysian Nuclear Agency have taken the initiative in signing a Memorandum of Understanding (MoU) with four Certified Seed companies, which are Sykt HMN (M) Sdn Bhd., Pertama Padi (M) Sdn Bhd., Kilang Beras Jelapang Selatan (M) Sdn Bhd (KBJS) and MADACorp Sdn Bhd. According to the Integrated Agriculture Development Area (IADA) and farmer's association in Northern Part of Malaysia, NMR152 is still consistently produced high yield (20% to 40%) in granary area as compared to the national average yield that is only 3.7 t/ha. Based on the data provided by the industrial partner [Sykt HMN (M) Sdn Bhd], rice mutant has been distributed throughout Peninsular Malaysia (Perak 22%, Selangor 20%, Kedah 16%, Pahang 16%, Perlis 5%, Kelantan 4%, Terengganu 3%, Melaka 2%, Negeri Sembilan 1% and Johor 1%) with total planting area around 20,000 ha.

Mongolia (Dr. Bayarsukh Noov, Institute of Plant and Agricultural Science)

Mongolia successfully applied the different mutagen sources such as ion beam (He 50 MeV, Carbon 320 MeV), X-ray and chemicals applied for mutation induction for wheat and barley. Thanks to our colleague from the Department of Radiation-Applied Biology Research, National Institutes for Quantum and Radiological Science and Technology Japan for great help for irradiation our seed materials during project implementation period. We would like to request Japan to continue this service to member countries. Totally, 1783 rows of 86 progenies screened in M1-M4 lines. In the yield trial, the two mutants including early maturity line Darkhan-225, mid maturity line Darkhan-234 had higher yield than control.

The Philippines (Mr. Christopher C. Cabusora, Philippine Rice Research Institute)

Induced mutation, by combining tissue culture and gamma irradiation, of the submergence tolerant rice cultivar, FR13A, generated elite mutant lines with improved agronomic traits and retain tolerance. One of these elite mutant lines were approved as new rice varieties in 2022 as NSIC 2022 Rc 686. This variety is also tolerant to drought and salinity.

Thailand (Ms. Prakobkit Dangthaisong, Rice Department)

Development of Thai rice varieties by application of gamma radiation had the objective to improve Thai rice varieties for tolerance to acid soils. The study was conducted from 2020 to 2021. Mutation breeding of rice began from Khlong Luang Rice Research Center with 23 elite rice lines were treated with gamma ray at the rate of 300 grays at Thailand Institute of Nuclear Technology in dry season 2020. Mutant progenies of M1 to M2 were planted and selected at farmer field in Nakhon Nayok province (soil pH 4.52) in wet season 2020 and dry season 2021. The 548 mutant lines from M2 (23 parents) were selected and distributed for

four locations to generate for M3 mutant progenies in wet season 2021. The results showed that 237 mutant lines of M3 was selected by Khlong Luang Rice Research Center, in addition 399, 511 and 630 lines were selected from Chachoengsao Rice Research Center, Pathum Thani Rice Research Center and Phatthalung Rice Research Center, respectively.

Vietnam (Dr. Le Duc Thao, Agricultural Genetics Institute)

In 2022, we started a new mutation breeding project to improve some key crops such as soybean, groundnut, rice and orange. The results on soybean and groundnut are of the M1 generation. This is the first time to apply mutation breeding to orange in Vietnam. The orange trees need a long time to breed, so we will continue to evaluate the growth ability and the variations that appear in the next year. As for the rice breeding in the M6 generation, 56 mutant lines were selected (31 lines from ST20 and 25 lines from VTNA6), including: 10 lines with shorter growth time; 6 lines had shorter plant height; 2 lines had a more compact type of tillering; 12 lines showed lodging resistant characteristics; 7 lines had erect flag leaves; 6 lines had increased number of grains per panicle; 6 lines had better grain arrangement; 8 lines showed higher yield.