ANNEX 4

Part A. Summary of Country Report on Plant Growth Promoter (PGP)

Part A-1. Country Report on Challenges in Commercialization of PGP

(1) Bangladesh (Dr Salma Sultana, Bangladesh Atomic Energy Commission (BAEC))

Oligo-chitosan was applied for its potential use as plant growth promoter and elicitor. Effects of oligo-chitosan on growth and productivity of tomato plants and egg plants were investigated as a field scale. The morphological characters of tomato and egg plants were studied randomly in different plants. The foliar spraying of oligo-chitosan with the concentration of 60 was applied both tomato and egg plants. The growth and productivity of these oligo-chitosan treated Tomato plants and Egg plants were compared with those of control Tomato plants and Egg plants. The effects of oligo-chitosan on Tomato's growth and productivity were investigated in terms of plant height, number of flowers, number of fruits, and weight of single fruits. The results showed that the application of oligo-chitosan plays a significant role in terms of plant height, number of flowers, number of fruits, and weight of single fruits per Tomato plant. The yield of tomato in terms of t/ha with combination of SWA & o-chitosan, o-chitosan, control are 111, 133, 48.75 respectively. The effects of oligo-chitosan on Egg plant's growth and productivity were also investigated in terms of plant height, number of flowers, number of fruits, size of single fruit and weight of single fruit. The results also showed that the application of oligo-chitosan plays a significant role in terms of plant height, number of flowers, number of fruits, size of single fruit and weight of single fruit. The yield of eggplant is not ready yet. The work is going on. It was also found that oligo-chitosan induced elicitor activity against fungal disease of tomato plant in under in-vitro and in-vivo conditions. In tomato plant effect of o-Chitosan on the radial growth of Rhizoctonia solani & Sclerotium rolfsii (Mycelial growth in mm) shows in control is 90 and increasing the concentration of o-chitosan radial growth of Rhizoctonia solani & Sclerotium solani & Sclerotium rolfsii decreased and at 6000ppm are 21.7 & 27.1 respectively. These results suggest that oligo-chitosan has potential use in agriculture purpose as growth promoter and elicitor.

(2) Kazakhstan (Mr Sergey Kotov, JSC "Park of Nuclear Technologies")

Some PGP samples of the Indonesian team were used for preliminary tests of PGP effectivity. Most of the samples are planned to be used on field tests, which are going to start in 2016 with "Atameken Agro" JSC. This JSC, as we think, is going to be the biggest customer in Kazakhstan for SWA and PGP. Production of the PGP is not tested in Kazakhstan, since there is a

difficulty with the access to raw material. The nearest raw material production is in China.

(3) Mongolia (Dr Amartaivan TSENDDAVAA, National University of Mongolia

Because of research budget, lack of human resources and irradiation facilities PGP and SWA research have not done for recent 2 years. From the beginning 2016, it was possible to start research on radiation processing of natural polymers for PGP and SWA production. In Mongolian case, it is difficult to get sustainable raw material for PGP, and research team have decided to conduct pot test/semifield test using PGP solution that produced by member states.

(4) The Philippines (Ms Charito T. ARANILLA, Philippine Nuclear Research Institute (PNRI))

The Philippine Nuclear Research Institute embarks on a new project on semi-commercial scale production of oligocarrageenan PGP and multi-location field testing for rice to be conducted in 7 regions in the country, covering a total testing area of 37,000 hectares. The required volume of PGP to cover the areas is about six hundred thousand (600,000) liters. With the current state of the Cobalt-60 facility (activity = 72.4 kCi), the production capacity is only 6,720/mo which will not sustain the objective. In order to meet the challenge, the Electron Beam Machine (2.5 MeV, 100 kW) will be utilized. The process for e-beam treatment of carrageenan solution is currently being tested using a newly fabricated liquid handling system. Experimentations are being done to establish optimum parameters for the processing, such as flow rate of solution, thickness of the flowing liquid and current. If optimized, the target production capacity is 150,000 L per month. The oligocarrageenan PGP has been given provisional registration by the Fertilizer and Pesticide Authority, since some requirements have to be fulfilled. It is hoped that full registration will be obtained by June 2016.

Part A-2. Country Report on New Research and Follow-up of Commercialized PGP

(1) Indonesia (Dr Darmawan Darwis, National Nuclear Energy Agency (BATAN))

1. Oligochitosan and biofertilizer give synergistic effect on plant height, trunk diameter and canopy of chili pant
2. Combination of oligochitosan and biofertilizer is effective in imoproving the yield of chili.
3. The Optimum concentration of oligochitosan and biofertilizer is 50 ppm and 20 gram respectively
4. Oligochitosan is effective as PGP and plant elicitor for many plants such as chili, red onion, zea mays, paprika, and cabbage

(2) Japan (Dr Mitsumasa TAGUCHI, Japan Atomic Energy Agency)

Oligo-chitosan, which is produced from chitosan by γ-ray irradiation, is known as an effective plant growth promoter. Dose for production of oligo-chitosan depended on the initial sample condition, for example, swollen or solid state, and additives. It is necessary to be optimized the manufacturing condition for commercialization. A simulation code was developed based on chemical reactions in water and degradation reaction of polymers under irradiation. Decomposition behaviors of chitosan in water with/without hydrogen peroxide are well reconstructed. Therefore, guideline for the suitable manufacturing condition can be provided by using the simulation code.

(3) Malaysia (Dr Marina Talib, Malaysian Nuclear Agency (Nuclear Malaysia))

Production and field test of Plant Growth Promoter (PGP) from chitosan by radiation processing were successfully conducted in Malaysia. A collaboration with Mutation Breeding Group and MUDA (Development Agriculture Authority) has offered a package which include oligochitosan, biofertilizer, liquid smoke and for field test on Mutant rice varieties: MR 219-4 and MR 219-9 at Utan Aji, Perlis (aerobic soil condition) and Pendang, Kedah (saturated soil condition). The test has improved the yield of MR219-9 in Pendang, Kedah from 6.3 to 8.05 tonnes/hectare. In Utan Aji, Perlis, the yield for MR 219-9 and MR 219-4 were 13 tonnes/hectare and 15 tonnes/hectare respectively. Application of oligochitosan with average molecular weight 9,395 Dalton was used for semi field test on Chili Kulai Hybrid F1 469 Plant by fertigation system. The field test cover from early stage of germination for 26 days follow with fertigation plantation of chili plant for 4 months. At germination stage, plant height and root length increased 11.9% and 57%, respectively compare to control without foliar of oligochitosan.

(4) Thailand (Dr Phiriyatorn SUWANMALA, Thailand Institute of Nuclear Technology)

Chitin was prepared from local shrimp shells. The prepared chitin was changed into chitosan, by chemical reactions. Radiation-induced degradation was used to reduce the molecular weight of the prepared chitosan, yielding oligochitosan. A production plant of PGP with the capacity of 50,000 liters /month was set up at Thai Irradiation Center, Prathumthanee Province.