Collaboration Research Proposal

Project Title: Development of Drought-Tolerant Soybean Crops

Project Description

Drought is a major environmental factor contributing to loss of crop yield worldwide. Moreover, the proportion of agriculturally important areas with an inadequate water supply has increased substantially as a consequence of global warming and an explosive increase in human population. To cope with drought stress, plants have been evolved to possess molecular mechanisms that coordinate expression of genes and metabolic pathway to protect them from drought stress and increase the chance of survival in arid regions Thus, the identification of plant drought tolerance mechanisms in crops and development of drought tolerant crops are important objectives.

Soybean is one of globally important crops, providing oil and protein. Over 300 million metric tons of soybean is produced and the top eleven countries produce over 90% of the world's soybean. Uruguay is one of the major countries and produced over 2.5 million metric tons of soybean. However, the production of soybean in Uruguay decreased 60% in 2017/2018 growing season. The reduction of soybean production was mainly caused by severe droughts. Therefore, development of drought-tolerant soybean crops ensures high productivity of soybean under drought conditions not only in Latin American countries including Uruguay.

Development of drought tolerant soybean crops:

Prof. Ju-Kon Kim's group of Seoul National University is working on identification of drought tolerance mechanisms in rice for over 20 years. His group recently identified the *DIAAT* gene involved in biosynthesis of branched chain amino acids (BCAA) that can be used for developing drought tolerant crops. Expression of *DIAAT* is rapidly induced upon exposure of plants to abiotic stresses such as drought, high salinity, low temperature as well as ABA. Overexpression of *DIAAT* in transgenic rice increases the plant tolerance to drought stress at the vegetative stage of growth. Moreover, *DIAAT* overexpression significantly enhanced drought tolerance at the reproductive stage, increasing grain yield by 24 to 40% over non-transgenic (NT) controls in the field under drought conditions. Amino acid analysis revealed an increase in BCAA levels in *DIAAT* overexpressing plants as compared to NT controls. Moreover, exogenous application of BCAAs mitigates PEG-driven osmotic stress. These indicate that *DIAAT* mediates drought tolerance through accumulation of BCAAs which functions as compatible osmolytes under drought conditions. Similar with rice, it is also reported that BCAAs are amino acids signficantly accumulated in soybean under drought conditions. Therefore, introducing *DIAAT* and furthern characterization of functional homolog of *DIAAT* in soybean will open a new window for development of drought-tolerant soybean crops.

Uruguayan partner's group is expected to have a long expertise in identification of drought tolerance mechanisms in crops. His(her) group is expected to have tools for transformation of soybean and for in-field evaluation of soybean plants under environmental stress conditions. The field test data is

crucial for drought-tolerant soybean to be commercialized, given that Uruguay and its neighbouring countries are major producers of soybean around the world.

Both groups are aiming to develop drought-tolerant soybean crops that are crucial to maintain stable soybean supply under unpredictable drought conditions. To achieve the goal, both groups will simultaneously attempt to introduce *DIAAT* gene (provided by Prof.Ju-Kon Kim) into Uruguayan varieties of soybean (provided by Uruguayan partner's group). The engineered soybean crops obtained through this collaboration will be tested for drought tolerance by Uruguayan partner's group in their experimental field.

This collaboration research will allow us to:

(i) Develop drought-tolerant soybean crops by modulating BCAA metabolic pathway. This has never been shown so far despite such contribution is suspected since long. The gene material available in Prof. Ju-Kon Kim's laboratory is perfectly adequate for this purpose.
(ii) To share technological tools for introduction of gene into soybean plants and systemic evaluation of soybean performance under field conditions.
(iii) To establish collaboration that is promising for technological transfer of knowledge and also for commercialization through a Start-Up company.
(iv) To exchange scientific ideas and to facilitate exchange of young researchers.