2010 Japan International Award for Young Agricultural Researchers

Experimental study on soil water repellency and its behavior

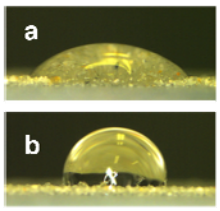
Dewpura Acharige Lilisiya LEELAMANIE, Senior Lecturer
University of Ruhuna, Democratic Socialist Republic of Sri Lanka

Reason of Awarding

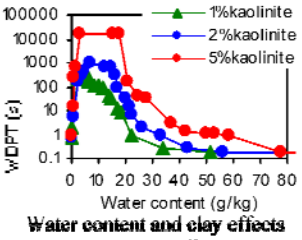
The awardee is conducting research on the mechanism of soil water repellency which is closely linked with soil erosion. Research was conducted on the relationship between water repellency and the presence of hydrophobic organic compounds in the soil, soil water and clay content and different analyses and evaluation methods using various model soils. This research is expected to contribute to the prevention of soil erosion on the slopes of tropical rainforest climate regions.

Outline of Research Achievements

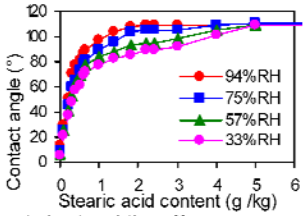
Soil water repellency is the situation where soil does not wet spontaneously when water is applied on the surface. It is caused by low-energy surfaces where the attraction between solid and liquid phases is weak. It is increasingly being recognized as a common phenomenon impacting soil hydrological functions, mainly infiltration, increasing surface runoff and erosion. This research focuses on soil water repellency, a very new field in Sri Lanka and in the world which is recently being expanded. In this research, the soil water repellency of various model soils has been examined using different repellency measurements. Major sub-themes are on important factors affecting soil water repellency and its behavior; the effects of hydrophobic and hydrophilic organic matter, clays, soil water content and relative humidity on water repellency; relationship between different repellency measurements; and time dependence of contact angle and its relation to repellency persistence. This research is very important to find an approach for erosion control in tropical slopes. All the findings are expected to have highly favorable impacts on agriculture and society.



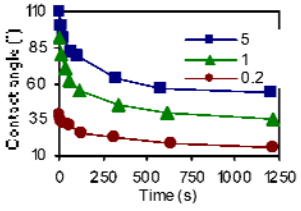
Contact angle on soil monolayer
a. Wettable b. repellent



Water content and clay effects on water repellency



Relative humidity effects on contact angle of hydrophobized soils



Time dependence of contact angle

Main Publications:

1. Leelamanie DAL, Karube J 2007: Effects of organic compounds, water content, and clay on the water repellency of a model sandy soil. Soil Sci. Plant Nutr., 53 (6), 711–719.
2. Leelamanie DAL, Karube J, Yoshida A 2008: Relative humidity effects on sessile drop contact angle and water drop penetration time of sand with hydrophobic coatings. Soil Sci. Plant Nutr., 54 (5), 695–700.
3. Leelamanie DAL, Karube J, Yoshida A 2008: Characterizing water repellency indices: Contact angle and water drop penetration time of hydrophobized sand. Soil Sci. Plant Nutr., 54 (2), 179–187

2010 Japan International Award for Young Agricultural Researchers

Development of multienzyme complexes for the effective degradation of lignocellulosic biomass

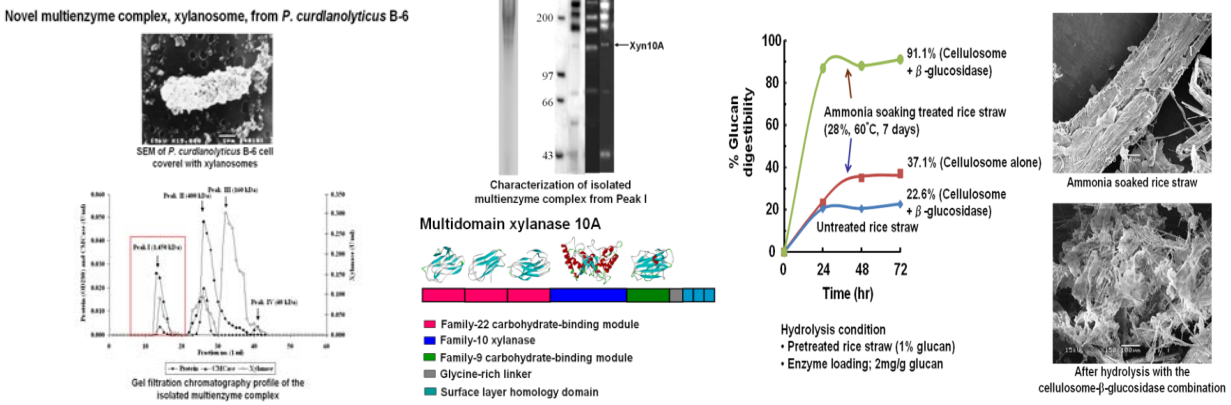
Dr. Rattiya WAEONUKUL, Researcher
King Mongkut's University of Technology, Thonburi (KMUTT),
Kingdom of Thailand

Reason of Awarding

The awardee is working on the development of a cellulosic ethanol production technology. The combination of the new cellulotic enzyme complex cellulosome from anaerobic bacteria and β-glucosidase enhanced the lignocellulose degradation of rice straw to glucose with higher efficiency. The research is expected to contribute to a bioethanol fuel production technology using biomass which does not compete with food production.

Outline of Research Achievements

Several anaerobic cellulolytic microorganisms such as *Clostridium thermocellum* had been able to produce a large extracellular polysaccharolytic multicomponent complex called the cellulosome under strictly anaerobic conditions. For the first time, it was found that a facultatively anaerobic bacterium *Paenibacillus curdlanolyticus* B-6 produces novel high molecular-weight multienzyme complexes termed the xylanosomes that contain strong xylanase activity under aerobic conditions. To elucidate a feature of xylanosomes, one of the subunits, *xyn10A* was cloned from *P. curdlanolyticus* B-6. Molecular structure was found to be composed of 9 functional domains including carbohydrate binding module (CBM) and xylanase, indicating that Xyn*10A* has an important role for plant cell wall degradation in the xylanosomes. For practical use of the multienzyme complexes in utilization of cellulosic biomass, the researcher isolated a potent cellulolytic *C. thermocellum* strain S14 from bagasse paper sludge in Thailand and developed an enzyme system composed of the hyper-cellulolytic cellulosomes from S14 and β-glucosidase from a thermophilic bacterium, *Thermoanaerobacter brockii*. Using the enzyme system, saccharification efficiency of 91% was attained with the ammonia-treated rice straw.



Main Publications :

1. Isolation and Characterization of a Multienzyme Complex (cellulosome) of the *Paenibacillus curdlanolyticus*. B-6 Grown on Avicel Under Aerobic Condition. 2009. J Biosci Bioeng. Vol.107: 610-614.
2. Cloning, Sequencing, and Expression of the Gene Encoding a Multidomain Endo-β-1,4-Xylanase from *Paenibacillus curdlanolyticus* B-6, and Characterization of the Recombinant Enzyme. 2009. J Microbiol Biotechnol. Vol.19: 277-285.
3. Effect of Carbon Sources on the Induction of Xylanolytic-Cellulolytic Multienzyme Complexes in *Paenibacillus curdlanolyticus* Strain B-6. 2008. Biosci Biotechnol Biochem. Vol.72: 321-328

2010 Japan International Award for Young Agricultural Researchers

Provitamin A biofortification in maize grain

Dr. Jianbing YAN, Scientist
International Maize and Wheat Improvement Center (CIMMYT) – China
People's Republic of China

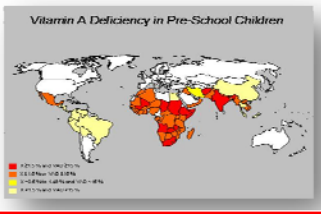
Reason of Awarding

The awardee, with the use of multiple techniques, discovered molecular markers for the provitamin A maize genes which can be used directly in breeding. These molecular markers are currently used in research institutions around the world. The cultivation of Provitamin A-biofortified maize with its higher Vitamin A content is expected to benefit the poor population who suffer from Vitamin A deficiency.

Outline of Research Achievements

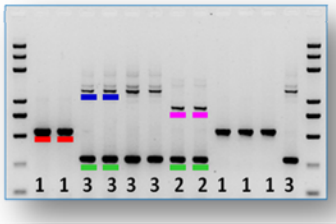
Vitamin A deficiency (VAD) negatively affects visual health in developing countries, afflicting nearly one-quarter of pre-school aged children, a population of approx. 127 million. Jianbing Yan and his colleagues showed that several major genes (*crtRB1*, *lcyE* and *psy1*) can improve the provitamin A content in maize kernel through association analysis, linkage mapping, expression analysis, and mutagenesis/E.coli assay. Four natural *lcyE* polymorphisms explained 58% of the variation in alfa-carotene versus beta-carotene branches of the carotenoid pathway and a threefold difference in provitamin A compounds. The combination of three *crtRB1* polymorphisms accounted for 40% of the phenotypic variation for beta-carotene which led to a 7.6-fold change between the average beta-carotene values of the most and least favorable haplotype classes. The favorable allele from one SNP of *psy1* could increase the total carotenoid contents by more than 10%. Seven PCR markers were developed based on the functional loci of the three identified genes. Selection of favorable gene alleles with inexpensive molecular markers will now enable breeders in developing countries to more effectively produce maize grain with higher provitamin A levels. Several institutes in the world, including CIMMYT, Purdue University, China Agricultural University, IITA, Hubei Academy of Agricultural Sciences, Yunnan Academy of Agricultural Sciences and South China Agricultural University, etc. are using the markers to breed high provitamin A maize.

VAD is a global challenge



High ProVA Maize Grain is Part of Solution to VAD

Robust, User- Friendly PCR markers are available



Main Publications :

1. Rare genetic variation at *Zea mays crtRB1* increases β-carotene in maize grain. Nature Genetics, 2010, 42: 322–327 doi:10.1038/ng.551
2. Nucleotide diversity and molecular evolution of the *PSY1* gene in *Zea mays* compared to some other grass species. Theor Appl Genet, 2010, 120:709–720 DOI 10.1007/s00122-009-1188-x
3. Natural genetic variation in lycopene epsilon cyclase tapped for maize biofortification. Sience, 2008, 319: 330-333