2011 International Award for Young Agricultural Researchers

Significance of root plasticity in maintaining dry matter production in rice under fluctuating soil moisture stresses

Dr. Roel Rodriguez Suralta
Senior Science Research Specialist
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Reason of Awarding

The award winner demonstrated that plasticity exhibited by root systems plays an important role under fluctuating soil-moisture stress, where drought and water-logged conditions occur repeatedly, which is typically experienced in rain-fed rice fields and water-saving cultivation environments. He conducted a linkage analysis on the traits of roots that enhance development of root systems in water-logged conditions preceded by drought, and identified a genetic locus linked to the traits involved in enhancing development of root systems. In the future, contributions to improving rice production in the rain-fed rice fields and water-saving rice fields that are often seen in developing countries, can be expected through utilization of this gene, identified in the analysis of existing varieties, and through breeding.

Outline of Research Achievements

Soils under rainfed lowland rice field may experience fluctuating soil water regimes ranging from drought to waterlogging and vice versa. The inability of roots to acclimate to such changes in hydrology may result in reduced growth and function, and less dry matter production. Dr. Suralta's research precisely identified key root traits that showed plasticity under fluctuating soil moistures such as increase in the branching of lateral roots and aerenchyma development by using chromosome segment substitution lines (CSSL). The plasticity exhibited by L type lateral root is one of the key traits that are responsible for the plasticity expressed by the whole root system under transient waterlogged-to-droughted conditions. Waterlogging was also proven to be stressful to rice when this stress is preceded by drought. Drought affected the ability of roots to enhance aerenchyma development under sudden waterlogged conditions, which led to poor internal atmospheric O_2 diffusion to the roots. The above root plastic developmental responses under the actual prolonged moisture fluctuations in the soil had significantly contributed in maintaining rice productivity. Research on root plasticity under fluctuating soil moistures is vital for understanding the physiology of rainfed lowland rice and its breeding applications for varietal improvement.

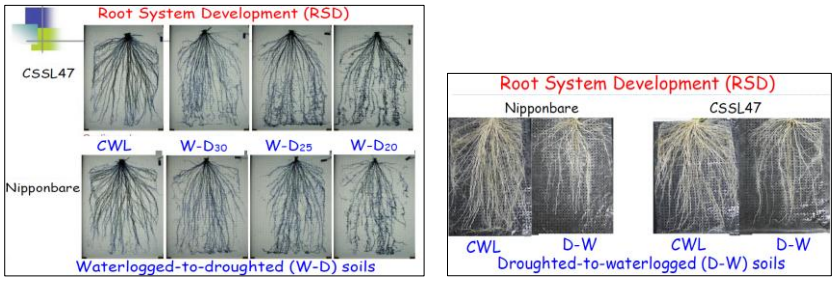

Fig. 1. Root plastic development in CSSL47 over Nipponbare parent under fluctuating soil moisture stresses

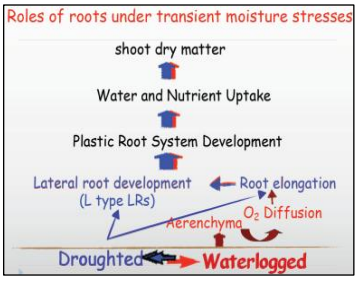

Fig. 2. Contribution of root plasticity

Main Publications :

(1) Suralta, R.R., Inukai, Y. and Yamauchi, A. 2010. Shoot dry matter production in relation to root growth, oxygen transport and water uptake under transient soil moisture stresses in rice. Plant and Soil 332:87–104.
(2) Suralta, R.R., Inukai, Y. and Yamauchi, A. 2008. Utilizing chromosome segment substitution lines (CSSLs) for evaluation of root responses under transient moisture stresses in rice. Plant Production Science 11: 457-465.
(3) Suralta. R.R., Inukai, Y. and Yamauchi, A. 2008. Genotypic variations in responses of lateral root development to transient moisture stresses in rice cultivars. Plant Production Science 11:324-335.

2011 International Award for Young Agricultural Researchers

Study on tick molecular biology with a view to development of novel control strategies for ticks and tick borne diseases

Dr. Muhammad Abdul Alim
Associate Professor
Bangladesh Agricultural University, People's Republic of Bangladesh

Reason of Awarding

The award winner identified a protein called Haemangin, a blood-sucking modulator found in the saliva of ticks, which prevents angiogenesis, cellular proliferation, and wound healing. The finding is promising in the areas of extermination technology development against ticks, utilizing the blood-sucking modulator of ticks. Haemangin may be a target for tumor angiogenesis.

Outline of Research Achievements

Ticks are notorious blood sucking ectoparasites. Ticks rank first for livestock and second only to mosquitoes in doing harm to humans as voracious blood suckers and as potential vectors of a number of bacterial, viral, protozoal and rickettsial diseases worldwide. Md. Abdul Alim and his colleagues by *in vitro* and *in vivo* gene functional analyses employing RNA interference (RNAi) gene knockdown technique have unmasked the molecular mechanisms of important tick biology and showed that several gene molecules (Legumains, Haemangin and Longistatin) play critical roles. Legumains are critically involved in blood-feeding, hemoglobin digestion cascade, and in egg and embryo development of ticks. Legumains are the key enzymes for midgut remodelling essential for microbial pathogen invasion and transmission by ticks. Ticks make a wound and blood pool under the host's skin for sucking blood. Haemangin prevents new blood vessels (capillary) formation and wound healing in tick bite area. Longistatin prevents blood coagulation by activating the blood coagulation factor, plasminogen and degrading fibrinogen, and keeps blood in fluid state in the blood pool which enables tick to feed successfully. The gene molecules that have been demonstrated are promising therapeutic/vaccine candidates to control ticks and tick borne diseases as an alternative of toxic chemical usages.

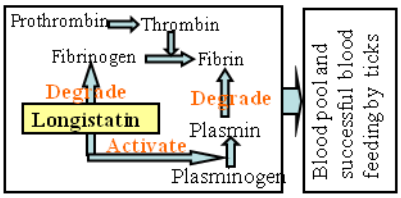

Fig. 1. Role of longistatin in blood pool formation

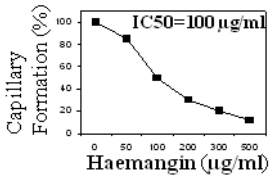

Fig. 2. Haemangin inhibited capillary formation

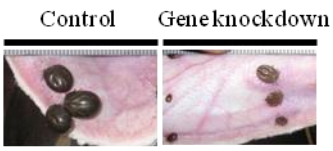

Fig. 3. Legumains modulate host blood feeding by ticks

Fig. 4. Legumains are critically needed for tick embryogenesis

Main Publications:

(1) M Abdul Alim, Naotoshi Tsuji, Takeharu Miyoshi, M. Khyrul Islam, Takeshi Hatta, Kozo Fujisaki. 2009. Legumains from the hard tick *Haemaphysalis longicornis* play modulatory roles in blood feeding and gut cellular remodeling and impact on embryogenesis. International Journal for Parasitology, 39(1), 97–107.

(2) M. Khyrul Islam, Naotoshi Tsuji, Takeharu Miyoshi, M. Abdul Alim, Xiaohong Huang, Takeshi Hatta, Kozo Fujisaki. 2009. The Kunitz-like modulatory protein haemangin is vital for hard tick blood-feeding success. PLoS Pathogen, 5(7):e1000497.

(3) Anisuzzaman, M. Khyrul Islam, M. Abdul Alim, Takeharu Miyoshi, Takeshi Hatta, Kayoko Yamaji, Yasunobu Matsumoto, Kozo, Fujisaki, Naotoshi Tsuji. 2011. Longistatin, a plasminogen activator, is key to the availability of blood-meals for ixodid ticks. PLoS Pathogen, 7(3) e1001312.

2011 International Award for Young Agricultural Researchers

Developing socially acceptable weed management strategies for resource-poor rice farmers

Dr. Jonne Rodenburg
Senior Agronomist
Africa Rice Center, Kingdom of Netherlands

Reason of Awarding

The award winner has been working consistently in Africa, and has established an integrated management method to control the root parasitic weeds to major upland crops, through an application of a farmer-participatory approach combining techniques that are acceptable by farmers and local villages, by selecting a variety with higher resistance to the parasitic weeds, which could grow without the need to control them. His study, based on farmer-participatory approach and with a focus on spreading the method in the future, gives the promising possibility that it will be widely applcable in Africa.

Outline of Research Achievements

Weed-inflicted yield losses in rice equate to half the current rice imports in sub-Saharan Africa (SSA) and African rice farmers have a limited range of effective and affordable weed management technologies. The Africa Rice Center aims at developing socially acceptable integrated weed management strategies for resource-poor rice farmers. An important component of integrated weed management is the use of improved varieties. Much of the research carried out in the past years therefore focused on the use of improved varieties and management strategies to enhance weed control for resource-poor farmers under current and future conditions. Dr. Rodenburg and his team and partners have identified mechanisms and developed screening methods for resistance and tolerance against parasitic weeds (*Striga* spp. and *Rhamphicarpa fistulosa*) and for improved weed competitiveness (both upland and lowland). Simultaneously, they have identified cereal varieties with superior resistance and tolerance against these parasitic weeds and superior competitiveness against ordinary weeds. Together with his collaborators and rice farmers, he has developed weed-competitive rice establishment methods and an improved and locally-adapted version of SRI that combined higher yields with lower water and agro-chemical inputs.

Rice farmers' meeting in Tanzania

Women weeding in a rice field in Kenya

Rice farmer applying herbicide in Ghana

Striga hermonthica on rice in Cote d'Ivoire

Discussing water measurement in an SRI trial in Senegal

Main Publications:

(1) Cissoko M, Boisnard A, Rodenburg J, Press MC, Scholes JD. 2011. New Rice for Africa (NERICA) cultivars exhibit different levels of post-attachment resistance against the parasitic weeds *Striga hermonthica* and *Striga asiatica*. *New Phytologist*, in press

(2) Rodenburg J, Saito K, Glele Kakaï R, Touré A, Mariko M, Kiepe P, 2009. Weed competitiveness of the lowland rice varieties of NERICA in the southern Guinea Savanna. *Field Crops Research* 114, 411-418

(3) Rodenburg J, Johnson DE, 2009. Weed management in rice-based cropping systems in Africa. *Advances in Agronomy* 103, 149-218