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A durian tree (right) lowered by cutting-back pruning in Chanthaburi Horticultural Research Center (Photo by Y. Yonemoto)

In This Issue

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Crop Germplasm Research at Tropical Agricultural Research Front

Tropical Agriculture Research Front

The Tropical Agricultural Research Front (TARF) is located on Ishigaki Island in subtropical climate, and thus takes advantage of its natural environment to deal with the development of agricultural technology for the tropical and subtropical regions. TARF was originally established in 1970, as a branch of the former Tropical Agriculture Research Center which is now the Japan International Research Center for Agricultural Sciences (JIRCAS), to carry out research on the introduction of new crops from the tropics and subtropics and their evaluation for agricultural characteristics. Research on breeding techniques was also carried out to promote agricultural development in tropical and subtropical regions.

Crop Germplasm and “Green Revolution”

A major breakthrough in crop yield improvement called the “Green Revolution” had been accomplished in wheat and rice. It is well known that the use of the genes of a “semi-dwarf” wheat cultivar from Japan designated “Norin-ten” greatly contributed to the development of short-statured, profusely tillering and highly productive wheat cultivars in many countries. “Semi-dwarf” genes from a local cultivar of rice in Taiwan, “Dee-geo-woo-gen”, also successfully lead to “Green Revolution” in rice production.

Importance of Crop Germplasm Resources

The Green Revolution in wheat and rice production is the most successful example where crop germplasm resources were used for crop improvement program that contributed to the world’s food production. Thus, it is very important to collect and evaluate crop germplasm, which includes landraces (selected and conserved for a long period of time by farmers), wild progenitors, and closely related wild and cultivated species (and related genera as well). These relatives are anticipated to possess useful genes for crop improvement programs for adaptation to stress environments and/or resistance to disease pathogens and insect pests.

Germplasm Collection and Evaluation for Crop Improvement at TARF

TARF also has a long experience of germplasm collection since its establishment, such as, tropical forage crop germplasm from East Africa, grain legume germplasm from South America, vegetable germplasm from Southeast Asia, etc. By evaluating these germplasm accessions in the experimental fields, we have successfully developed several crop varieties so far. To present an overview of our activities in crop variety development, we recently prepared a calendar and postcards where the breeding procedures of the varieties/strains we developed are briefly explained along with beautiful pictures. We hope that you will find these calendar and postcards interesting and useful.

At present, we are carrying out germplasm research for crop improvement as described below:

To develop high biomass-producing plants, we are conducting intergeneric crosses between sugarcane (*Saccharum officinarum*) and the genus *Erianthus* germplasm accessions. We likewise have already produced sugarcane strains which have much higher sugar content and stem yields than conventional cultivars by backcrossing sugarcane to the F1 hybrids between sugarcane and wild sugarcane (*S. spontaneum*).

Durian (*Durio zibethinus*), the king of tropical fruits, is subject to infestation with phytophtora pathogens. This disease is one of the most serious problems in durian cultivation. To overcome this disease through the development of resistant varieties, we plan to screen durian germplasm, including its wild relatives, in collaboration with the Malaysian Agricultural Research and Development Institute (MARDI), which conserves a large number of durian germplasm accessions.

Mungbean (*Vigna radiata*), one of the most important grain legumes in Asian countries, is seriously damaged by infestation with bruchid beetles during storage. On the other hand, blackgram (*V. mungo*) shows some resistance to some bruchid species. Thus, we are transferring the resistance from blackgram to mungbean by backcrossing procedures.

Yoshinobu Egawa
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Low Tree Height-Cultivation Technique for Durian and the Diversity of Genetic Resources for Breeding

Durian, the king of fruits, represents high-value tropical fruits in Southeast Asia. Thailand has the biggest production of durian (about one million tons) followed by Malaysia (about 400 thousand tons). Five to ten percent of these fruits are exported. Durian constitutes more than 30% of the total fruit-growing areas in Malaysia indicating that durian is the most important fruit tree in Malaysia.

Although durian trees grow more than 20 m in height, growers do not usually practice training or pruning. Consequently, the quality of the fruits is inferior due to insect infestation and disease infection exacerbated by crowded tree canopies. Besides, the labor cost for spraying, thinning and picking increases as the tree becomes taller.

JIRCAS' Tropical Fruit Project is therefore developing a low tree-height-cultivation technique for durian to improve fruit quality and reduce labor cost. To keep a fruit tree low without using dwarf rootstocks, it is necessary to expand the canopy horizontally. We cut back 5-year old durian trees (about 5-meter tall) at a height of 3.5 meter. Then we thinned the canopy by removing some branches to enhance the growth of the other branches. Some water sprouts appeared for only two years after cutting back. The canopy has been expanding horizontally while maintaining its height of 3.5 meters. The basic technique for low tree height-cultivation of durian has been established, though further development is necessary as the trees continue growing.

Malaysia is recognized as the geographic origin and the center of diversity of durian (*Durio spp.*) in the world. There are over 100 durian cultivars, including several elite varieties, in Malaysia. Moreover, a number of elite varieties are likewise widely distributed in Southeast Asian countries. Most of them, however, have not yet been subjected to intensive breeding process because of insufficient information on their genetic background.

The disease of phytophthora (Photo 2.) is one of the most serious problems occurring everywhere in cultivated areas. The most effective method to overcome this disease is to develop resistant varieties. The first step in the development for resistant varieties is to utilize durian genetic resources.

Malaysian Agricultural Research and Development Institute (MARDI) holds the world's largest collection of representative durian genetic materials in its genebank. It is possible that breeding materials for disease resistance could later be found among the genetic resources distributed in Malaysia.

Collaborative studies between MARDI and JIRCAS on utilizing the diversity of durian genetic resources for developing disease resistance materials are now being prepared.

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Photo 1. Durian fruits (Chanee, Phuang Mani, and Mon Thong)

Photo 2. Phytophthora disease of a durian tree

New-type Sugarcane Strains with High Yielding and Ratooning Abilities Bred through Interspecific Crossing between Sugarcane and *Saccharum spontaneum* for Sugar and Ethanol Production

JIRCAS has been working on the development of new crop materials and their utilization technology to sustainably produce both food and energy at the same time despite severe environments for crop production while minimizing competition between food production and energy production. Our project titled, "Development of sugarcane materials by interspecific and intergeneric hybridization using wild germplasm to diversify sugarcane utilization," in collaboration with Khon Kaen Field Crops Research Center (KKFCRC) of the Department of Agriculture, Thailand, is one of the activities for this purpose.

There are two reasons why this project is being conducted in Thailand. First, abundant genetic resources are available because many wild species closely related to sugarcane such as *Saccharum spontaneum*, *Erianthus arundinaceus*, *Sclerostachya fusca*, etc. are widely distributed in the country. Second, the Northeast region has a very long dry period and very sandy soil, which are very severe conditions for crop production, hence showing low productivity of sugarcane. Thus, we focused on the remarkable abilities of the wild relatives and have tried to develop interspecific and intergeneric hybridization techniques between sugarcane and its wild relatives to produce new-type sugarcane strains with high yielding and high ratooning abilities which could exhibit stability even under unfavorable environments for crop production.

An almost ten-year study enabled us to breed some better strains which are expected to possess high biomass yield with higher productivity of sugar and ethanol even in such severe environments as can be found in the Northeast region (Table 1.). The production rate per unit area of sucrose, glucose and fructose, which are constituents of commercial sugar and fermentable to ethanol, was found higher than those of the commercial sugarcane cultivars (Table 1.). Although, the sugar accumulation in stalks was not as high as that in the commercial sugarcane cultivars. In addition, these hybrids show good regrowth ability after harvesting.

We would like to introduce our strains to sugar millers and farmers as soon as possible so they can apply them in practice in a real economic activity. Toward such direction, it is of great importance for them to understand new products thoroughly. Thereby, evaluation experiments on the new strains' resistance to important diseases and response behaviors to fertilization and irrigation are now being undertaken to enrich the performance data for registration of these strains as new varieties in Thailand.

Development of breeding materials to diversify sugarcane utilization
Akira Sugimoto and Shuichiro Tagane
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Photo 1. Strains from interspecific crossing between sugarcane and *S. spontaneum*.
(Photo by Akira Sugimoto, December, 2007 at the KKFCRC ThaPra Campus)

Table 1. Major traits of expected clones

name	Cane yield (t/ha) planting	Cane yield (t/ha) ratoon	Numbers of stalks /ha planting	Numbers of stalks /ha ratoon	Juice brix (%) planting	Juice brix (%) ratoon	Fiber content (%)
04-4-142	54.4	**143.8**	560,900	929,487	22.2	20.8	13.7
04-4-377	69.4	**173.7**	520,818	817,306	22.2	21.1	10.7
04-4-410	67.5	**145.8**	801,287	1,298,075	20.2	20.8	13.8
K88-92	55.8	76.6	363,943	312,831	21.2	20.8	10.2
KK3	55.6	74.8	436,956	344,537	24.8	23.2	12.2

Note:
K88-92 and KK3 are commercial cultivars recommended in Northeast Thailand and the others are interspecific BC1 strains between sugarcane and *S. spontaeum*.

Management for the Reduction of Young 'King mandarin' Trees Infected by Citrus Greening Disease in the Mekong Delta Region

Citrus production, especially of the cultivar 'King mandarin' for domestic demand, is prevalent in the Mekong Delta area of Vietnam under its mild climate. One of the advantages of citrus production in Mekong Delta is that citrus trees grow vigorously throughout the year because of minimal change in air temperature all year round. Thus, a farmer can start harvesting as early as three years after transplanting the seedlings into a grove. Anyway, citrus greening disease (HLB) has been sweeping into this area, causing serious damages to the citrus industry since the 1990s. HLB is caused by a bacterium (*Candidatus* Liberibacter asiaticus) which is transmitted by the insect vector (citrus psyllid). There is no effective cure for this disease; once citrus trees are infected by this disease, they usually die within 2-3 years after the first symptomatic manifestation. Because an infected citrus seedling dies before fruiting, the damage becomes more serious when citrus trees are infected in the early stage of growth. This makes it difficult to produce citrus sustainably in Mekong Delta. Thus, the prevention of HLB infection in the early stage of growth seems to be important to prolong the economic lifespan of a citrus grove to the advantage of citrus production in Mekong Delta.

To date, the prevention system of HLB in the early stage of citrus growth in this area is the use of disease-free seedlings and continuous application of Neonicotinoids (insecticide) starting from two months after the transplanting and continued thereafter at an interval of every two months. However, the seasonal dynamics of psyllid population density and the possibility of infection that might occur two months after the transplanting had not been taken into account in the system. Therefore, there are some cases wherein almost all of the trees were infected by HLB in a year even though disease-free seedlings were introduced. As the expensive investment to protect citrus trees from HLB became fruitless, farmers became skeptical about the efficacy of the prevention system.

In order to clarify the effective timing of the application of Neonicotinoids and the ideal season for transplanting to avoid HLB infection, we investigated the seasonal changes of HLB infection risk based on the psyllid population and the efficacy period of Neonicotinoids in 'King mandarin' seedlings after application, in collaboration with the Southern Fruits Research Institute (SOFRI) of Vietnam. The population density of the psyllid increased during the latter half of the dry season, and accordingly the risk of occurrence of the disease became high. On the contrary, it started to decrease from the latter half of the rainy season, and remained low through the early half of the next dry season. Neonicotinoids showed their efficacy for two months starting from 10 days after the application. Based on these results, we confirmed that the combination of transplanting disease-free seedlings in the low-psyllid-population period and the application of Neonicotinoids 10 days before transplanting was effective to prevent HLB infection in the first year of growth in the treated grove (Fig.1). We expect that this new prevention system against HLB will bring to citrus growers more profits relative to their investment and contribute to the sustainability of the citrus industry in the Mekong Delta.

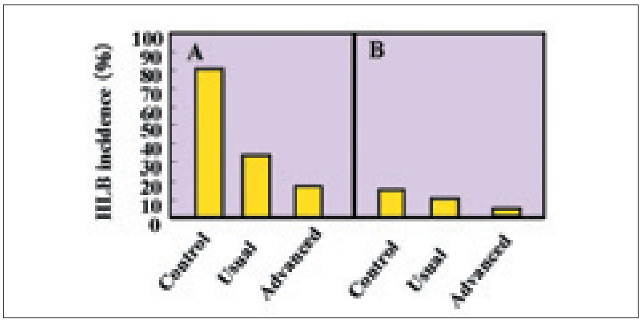

Fig. 1.
Effects of the transplanting season and the timing of the application of Neonicotinoids on the annual incidence of Huanglongbing (HLB) in King mandarin after transplanting.
A. Transplanted in May, 2007 (late in dry season: psyllid population was high)
B. Transplanted in November, 2007 (late in wet season: psyllid population was low)

Usual application: Neonicotinoids were applied at an interval of every two (2) months starting on the second month after transplanting.
Advance application: Neonicotinoids were applied 10 days before transplanting and at an interval of every two (2) months from transplanting.

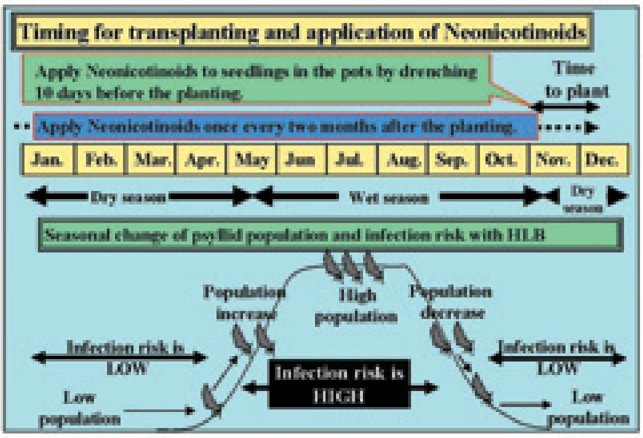

Fig. 2.
A guide for the prevention of Huanglongbing in the early stage of growth of King mandarin in Mekong Delta, taking into consideration the seasonal changes of the psyllid population and infection risk of the disease.

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