

Summary of Research Achievement in 2001

Banana Variety Improvement

Collection and Conservation of Banana Germplasm

Three wild types of banana were collected from Lanyu Island for conservation and characterization. A total of 214 accessions of banana germplasm were continuously preserved using in vitro and in vivo methods.

Selection for Resistance to *Fusarium* Wilt

A total of 3,433 banana plantlets of Ecuador Dwarf were used for the screening for resistance to *Fusarium* wilt (race 4) by screen-house method. 521 plants were selected as putative resistant plants for further investigation. Among 174 clones verified for the *Fusarium* wilt resistance, 14 of them showed intermediate to high level of resistance in the diseased field. Two out of 10 putative resistant clones subjected to intermediate field evaluation continued to perform well in diseased field and will enter yield trial next year. Two advanced resistant clones, GC-1089 and TC3-1035 showed good general horticultural characteristics. But the hand shape of GC-1089 was abnormal and irregular and thus was eliminated. Another semi-dwarf resistant clone TC3-600 continued to show good bunch size which is better than that of its mother cultivar "Tai-Chiao No.3".

Banana Variety Diversification

K. Khai and Cv. Rose were two diploid bananas selected for field evaluation. K. Khai is good in flavor while Cv. Rose has good field resistance to *Fusarium* wilt. They will be further investigated.

Banana Tissue Culture

Improvement in Banana Micropropagation Technique

In the micropropagation system, adventitious buds of *Pei-Chiao* from the 4% to 6% subculture when adding Dropp (0.1 to 0.2mg/l) and PP333 (0.5 to 1.0mg/l) to the MS medium, the multiplication rate was increased. *Pei-Chiao* adventitious bud clumps obtained after subculturing continuously for three times in medium containing Dropp and PP333, upon transferring into the temporary immersion system, the multiplication and elongation of adventitious buds was enhanced. The multiplication rate of the cultivar *Formosana* is lower than that of *Pei-Chiao*. The same trend was observed when Dropp and PP333 were added to the multiplication medium.

Necrosis of Adventitious Buds in the Cultivar "Formosana"

The adventitious buds of *Formosana* after subculturing in medium containing BA for 30 days, some of the propagules would become necrotic. This phenomenon certainly decreased the efficiency in micropropagation. Adding Dropp and PP333 to the solid culture medium or in the temporary immersion system could increase the multiplication



rate of buds and also delay the appearance of necrosis.

Disease and Pest Control

Commercialization of the New Variety Formosana for Controlling Fusarium Wilt

The new, high-yielding, wilt-resistant clone GCTCV-218 was officially named as the new variety *Formosana* in December 2001. A new planting program for *Formosana* was made immediately in 2002 covering 1,378 ha for controlling Fusarium wilt, accounting for about 1/4 of the total banana growing acreage in Taiwan. Results of marketing surveys conducted over a 2-year period revealed that the *Formosana* fruit has better hand shape, longer shelf-life, and lesser amount of loss during shipment than those of the conventional variety *Pei-Chiao*, thus well accepted by both domestic and Japanese market. It is believed that commercialization of this new variety would have the major impacts on Taiwan banana industry as follows: (1) The loss of banana production to Fusarium wilt will be reduced from the current level of 15% to less than 5% each year; (2) Yield per hectare will be increased by 40-50%; (3) The percentage of abnormal fruit which fails to degreen will be reduced significantly; (4) More even fruit quality is attainable based on planting *Formosana* exclusively for export; and (5) As a result of lower production cost and improved fruit quality of *Formosana*, Taiwan banana will become more competitive in the international market, offering a better chance to enter the new export market, in addition to the Japanese market.

Establishment of Mechanized Corporate Farming System for Commercial Production of *Formosana*

Too high production cost, too heavy damage to the fruit skin and uneven fruit quality are the major production constraints for Taiwan banana under the small-producer farming system. These problems are rendering Taiwan banana less competitive in the export market. The key to solving these problems is to increase production unit by introducing a mechanized, corporate farming system. With collaboration of the Taiwan Sugar Company, two corporate banana farms, 30 ha each, were established recently on sugarcane land in southern and central part of Taiwan. The new variety *Formosana* was chosen for planting which aims at production of spring bananas for the former and autumn/winter bananas for the latter. The machineries introduced from abroad for using in these corporate farms include bagging machine, bunch transportation tractor and an automatic packing shed. Feasibility of adopting this new banana farming system in Taiwan is now being under investigation.

Major Problems Affecting Survival Rates of Tissue Cultured Plants on Banana Farms

A field survey in the major cultivated areas of banana plants revealed that survival rate of tissue cultured plantlets after transplanting to field averaged 90% in 2002. The major causes of the death of plantlets were identified to be CMV, Fusarium wilt, herbicide and fertilizer damages.



Comparison of the Resistance of Tissue Cultured Plantlets and Suckers of *Formosana* to Fusarium Wilt

At mid-stage of banana plants of *Formosana*, the incidence of Fusarium wilt of tissue cultured plantlets and suckers in a heavily infested test plot was 13.3-22% and 2.2-8.6%, respectively, indicative of a higher degree resistance of suckers to Fusarium wilt than tissue cultured plantlets.

Improvement of Tractor Sprayer for Controlling Foliar Disease on Cooperated Banana Farm

Tractor equipped with mist sprayer could spray chemical evenly to leaves of banana plants at a speed of 3.3 ha per hour on a cooperated banana farm implemented with double-row planting system. The improved 4-wheel sprayer ran smoothly regardless of the topographical and soil conditions of the banana farm.

Incidence of Corky Scab of *Formosana*

Field survey of incidence of corky scab of banana hands on both *Formosana* and *Pei-Chiao* cultivars at shooting stage in late April, 2002 indicated that corky scab rating for hands of *Formosana* and *Pei-Chiao* cultivar was 0.6 and 0, respectively. It suggests that the fruit bunches of the new variety *Formosana* were more vulnerable to the corky scab than those of *Pei-Chiao*, and the chemical spray for controlling thrips should not neglect for this new variety.

Study on the Cause of Finger Tip Rot of Banana

Based on the results of physiological characteristics, biology plate indexing and sequence analysis of 16S rRNA, the causal agent of finger-tip rot of banana was identified as *Burkholderia cepacia*. When tips of normal banana fingers at young stage were inoculated with bacterial suspension of purified *B. cepacia*, typical symptom of finger tip-rot similar to that seen in the nature was developed 2-3 weeks later.

Detection of Moko Disease

Isolations made either from pseudostem tissue of banana plants showing leaf yellowing and wilt symptoms or from ornamental plants of different cultivars of *Heliconia* spp. in Kao-Ping area between May-July 2002 did not detect the presence of *Ralsotania solanacearum* race 2, the causal agent of Moko disease.

Cultivation and Post harvest physiology

Cultivation Management of the new variety *Formosana*

Application of organic fertilizer to banana farms growing *Formosana* did not show beneficial effects on the growth, yield and post-harvest quality of banana.

Production on Organic Bananas

As compared to the conventional cultivation of bananas, there were several parameters found inferior in the organic farming, depending on the cultivar or clone, including the number of healthy leaf at shooting, shelf life, and total soluble solids. The effects of organic farming on plantation soil were an increase in organic matter content,



unwavering pH, and the increased amount of available phosphorus and exchangeable potassium. The suppressive effect of organic farming on Panama disease drew attention of further investigation.

Prevention of Uneven Degreening Bananas

In the cropping year of 90/91, the use of blue polyethylene (PE) bunch bag and kraft paper bag in the plantations of Kaohsiung and Pingtung areas remarkably dropped 16.1% and 9.6%, respectively. In Kaohsiung area, the percentage of using kraft paper was only half of that in the cropping year of 89/90. No bunch bags of various colors and materials were found effective to entirely avoid the occurrence of uneven degreening of Taiwan bananas.

Causes and Prevention of Rubbery Bananas

The percentage of rubbery banana occurring in Kaohsiung and Pingtung areas was 1.35% in the cropping year of 89/90, which was about one half of that in the year of 88/89. Field trials by adding potassium sulfate to the rubberiness-prone and strongly acidified banana plantations promoted slightly the occurrence of rubbery bananas. Based on pulp resistance to a flat-headed 0.5mm metal probe was a reliable method in determining the degree of pulp rubberiness, better than chewing judgement. Pulp analysis again revealed this year that potassium content was significantly higher ($p < 0.05$) and calcium content lower in the rubbery bananas than in the normal bananas. The activities of pectinesterase in the rubbery bananas were higher than those in the normal bananas, the opposite was true for polygalacturonase. Applications of potassium sulphate did not change the activities of pectinesterase in banana pulp, but reduced the activities of polygalacturonase.

Technical Service

Propagation and Extension of Disease Free Banana Plantlets

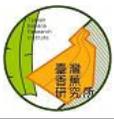
Plantlets of *Pei-Chiao* 842,970 and *Formosana* 2,099,996, totalmg 2,942,936 were propagated and supplied to the Fruit Cooperative for distribution to banana growers and one corporate plantation of Taiwan Sugar Company, respectively, during the period from November, 2001 to April, 2002.

Estimate of Banana Harvesting Time and Production

According to the result of shooting survey, the season of banana production this year was predicted to be earlier and the average bunch weight was lower than that of 2000/2001 season due to the influence of typhoons in 2001. The total production in Kaohsiung and Pingtung area during the period from January to July 2002 was estimated at 1.9 and 1.8 million cartons (12.6kg/carton), respectively.

Forecast of Disease and Pest and Their Control

Based on the information of disease and pest forecast, ground spray for the control of foliar diseases and fruit pests was carried out 10 and 7 times, respectively. Disease severity survey carried out in November 2001 revealed that the banana plants derived from suckers at shooting stage had retained only 7.8 healthy leaves in the sprayed areas, indicative of an



unsatisfactory result, while those grower from tissue cultured seedlings averaged 9.5. During the period from February to July 2001, 31 out of 70(43.3%) packing station having bananas rejected for export to Japan, was due to insect damage. The kind of insects observed and percentage of packing stations having quarantine problem of insects were mealybug 5.4%; moths 3%;larvae suspected of cluster caterpillar 0.3%. The incidence of insect problem detected in 8.7% of banana packing stations during export season in 2001 was lower than that of 2000.

Education and Extension Program

To promote banana production and improve fruit quality, demonstrations of cultivation technologies and lectures for banana growers were conducted in collaboration with the Fruit Cooperative. A total of 1,062 banana growers attended the meetings this year.