Update on banana research and development in Taiwan

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For the improvement of banana production, the Institute received a budget totaling US$1.5 million in 1999 which was used for conducting 16 research projects, of which 13 are applied research projects and 3 are technical service projects. About 60% of this funding came from government support and 40% from banana growers. Research work covered varietal improvement, tissue culture, disease and pest control, cultivation technology, postharvest physiology and technical service, with the key target to breeding for *Fusarium* race 4 resistance through somaclonal variation/mutation approach. The main research achievements are summarized below.

VARIETAL IMPROVEMENT

1. A total of 214 accessions of banana germplasm had been maintained both in vitro and *in vivo*. To search for an improved *in vitro* conservation method, PP333 and TDZ were added to MS medium. After one year, neither PP333 nor TDZ showed any advantage over the traditional method in terms of the extension of the duration of conservation. In another experiment, a simple method of placing a piece of serene wrap on the top of test-tube cap showed significant reduction in the rate of contamination.

2. Among 5092 banana plantlets used for screening for resistance to fusarium wilt (race 4) by screenhouse method, 182 were symptomless and subjected for further investigation. Among 88 clones to be verified for their resistance to fusarium wilt, three showed high level of resistance and will be further investigated.

3. After seven years of evaluation, a semi-dwarf *Fusarium* resistant clone, TC1-229 showed merits of wind tolerance and labor saving. Experimental data were compiled and submitted for approval of cultivar registration as Tai-Chiao No.3.

4. Experiment on gamma-irradiation was conducted in 1999. Newly prepared adventitious buds irradiated with 40 Gy was found to be the optimal treatment for mutation induction. After treatment, mutation rate of plantlets in the nursery was about 30%. The objective of this experiment is to select for disease resistant clones using mutation breeding.

5. Characterization of 10 local cultivars was completed and submitted to the Council of Agriculture, Executive Yuen this year. On May 1, it was announced that the cultivar registration and multiplication of banana (*Musa* spp.) was included in the 'Plant Seed Law'.

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Tissue culture

6. The effective concentration of Thidiazuron (TDZ) on the induction of adventitious buds in three banana cultivars Pei-Chiao, Tai-Chiao No.1 and Latundan was 0.05 to 0.2 mg/l. At higher concentrations (0.2 to 2.0 mg/l), TDZ appeared to suppress the elongation of adventitious shoots and induce large numbers of small globular buds. The effect of TDZ (tissue culture grade) and Dropp (agrochemical grade containing 490 g/kg TDZ wettable powder) on the induction of adventitious buds was about the same. Hence Dropp can replace the expensive tissue culture grade TDZ in commercial micropropagation.

7. The effect of TDZ differs in different cultivars and also in different stages of subculture. The combination of TDZ or Dropp (0.2 mg/l) with BA (4.0 mg/l) and Paclobutrazol (PP333) (0.5 to 1.0 mg/l) significantly increased the multiplication rate of shoots. The best sequence of application of TDZ or Dropp in banana micropropagation is to induce adventitious buds from suckers using BA for the first and second subculture, transfer the propagules to Dropp in combination with PP333 at the 3rd or 4th subculture and continue for 2-3 subcultures. At the 6th subculture, propagules should return to medium containing only BA to facilitate the elongation of bud clusters and in the subsequent subculture for plantlets regeneration.

8. Results of field survey showed that tissue culture plants propagated by TDZ gave 2.4% of off-type plants among 1800 plants and the control group was 3.0% among 400 plants tested.

9. The soil-free planting mix developed last year is now widely used in the Kao-Ping local nurseries for acclimatization of banana plantlets. The formulation consists of saw-dust:organic fertilizer = 2.5:1(v/v). This planting mix is economical and convenient for seedling transport.

Disease and pest control

10. Fusarium wilt resistance of the newly selected clone GCTCV-218 was confirmed in the 2nd year test. Results of resistance test conducted in two separate severely diseased farms showed that disease incidence of GCTCV-218 was 8.3%, which was significantly lower than 27.3% of Tai Chiao No.1 and 65.5% of Pei Chiao. Disease incidences of this clone among 10 farmer's farms surveyed averaged 4.3% ranging from 2.4 to 11.8%, while those of Pei Chiao averaged 25.5% ranging from 14.1 to 63.7%. In comparison with the traditional cultivar Pei Chiao, this resistant clone possesses distinctive agronomic and horticultural characters of the following: (1) It is 2.6-2.9 m tall, about the same as Pei Chiao, but its pseudostem is larger and stronger; (2) It produces a larger bunch, about 5.8 kg heavier than that of Pei Chiao; (3) Banana hands are more uniform in size, and they ripen normally giving an excellent taste as good as Pei Chiao; (4) It takes about 12-13 months from planting to harvest, about 1-1.5 months longer than does Pei Chiao.

11. Propagation of 80 000 tissue-cultured plantlets were made for planting over 40 ha, including the cooler central part of Taiwan, in April-May 2000 for the 3rd year evaluation. Results of field test in the past two years suggest that GCTCV-218 has a great potential for commercial planting for controlling fusarium wilt. It is estimated that replacement of the wilt-susceptable Pei Chiao with this resistant clone would
increase the banana yield from the current level 30.4-44.5 tonnes/ha, thus greatly increasing the competitiveness of Taiwan bananas in the Japanese market.

12. Results of field trials showed that removal of diseased leaves alone, without fungicide spray, was found to be effective for controlling freckle disease. By using this control measure, banana plant retained 11-13 and 8.8-10.8 healthy leaves at shooting stage, respectively, in the farm established by tissue cultured plantlets and in the ratoon crop. Fungicide spray using a roll of rubber tube connected to a pump engine gave the most satisfactory control of freckle disease, followed by 4-wheel blast sprayer and solo knapsack mist sprayer. However, the 4-wheel blast sprayer is recommended for use in the corporated plantation because of its lower labor cost.

13. At pot stage, incidence of heart rot in plantlets was 4.9-5.6% in a growth medium consisting of sawdust:bagasse compost (2.5:1 v/v), which is significantly lower than those growing in the traditional growth medium of sand:carbonated rice husk (4:1 v/v), 8.3-36.8%.

14. Based on the field survey conducted from 1995 to 1999, it was found that percentages of CMV on tissue cultured plants were 9.5% in March, 3.5% in April, and 1.5% in May. Reduction in CMV incidence from March to May could be related to the rising temperature and higher rainfall affecting the propagation and migration of aphid vector. Using shiny plastic mulching in the banana farm was found to be effective for controlling CMV.

15. A widespread field survey revealed that the survival rate of tissue cultured plantlets after transplanting to farm averaged 84.8% in 1998/1999 and 90% in 1999/2000. The major causes of the death of seedlings were identified to be CMV and heart rot. A severe case of marginal necrosis on leaves involving about 120 ha of banana farms was found in Chi-Shan area in October 1999. Evidences obtained from foliar analysis indicated that it was caused by the floride toxicity resulting from the nearby brick factory.

16. During the period of March-May 2000, bananas were rejected in many shipments to the Japanese market due to the insect problem. The insects identified were coconut moth (Tirathaba mundella), scab moth (Nacoleia charesalis), banana stem weevil, and mealybug. The insect damage to banana fruit is most likely associated with farms intercropping with coconut and betelnut, especially under poor field sanitation conditions.

**Cultivation and postharvest physiology**

17. In a medium-textured, well-drained banana farm, the fertilization management should follow the principle of a high potassium supply rate, Tai-Fei compound fertilizer No. 4 was highly recommended. Banana plants receiving fertilizers of a higher nitrogen and a lower potassium grade could result in the losses both in yield and postharvest qualities. Banana plants under the first year of organic farming would delay bunch emergence, however, the pseudostem girth, finger number, bunch weight, shelflife and titratible acidity were higher in organic plants, as compared to conventional plants.

18. Banana bunch protection using kraft paper bags or blue PE bags had no significant differences in the bunch development. It was proved consistently that kraft paper
bags could effectively prevent the occurrence of sunburn and uneven degreening in banana fingers and, additionally, it increased the peel degreening rate and the content of total soluble solids. During the years from 1996 to 2000, the use of kraft paper bags was increased from 0.5% to 34.5% of the banana plantations in Kaohsiung and Pingtung areas, indicating a remarkable progress in promoting the replacement of blue PE bags with kraft paper bags. Bananas harvested from the intercropped betelnut and coconut farms and from the ordinary farms in Kaohsiung and Pingtung areas did not show significant differences in the fruit qualities.

19. Study on the postharvest properties of GCTCV-218 showed that the length of precooling time had no effects on the rate of peel degreening and shelflife, but a longer precooling time could increase total soluble solid content of both Pei-Chiao and GCTCV-218. A ripening temperature model of 20°C-18°C-16°C was adequate to achieve peel degreening of GCTCV-218.

20. Pectin content of rubbery bananas was 3-4 times as much as that of normal bananas. Failure of polygalacturonase (PGA) to hydrolyze pectin could be due to the compartmentation between the enzyme and the substrate. It was conjectured that starch in rubbery bananas was hydrolyzed mainly through amylolytic pathway.

Technical service

21. Disease-free plantlets of Pei-Chiao (2,320,624), Tai-Chiao No. 1 (281,949) and Tai-Chiao No. 2 (451,558), with a total of 3,054,131 were propagated and supplied to the Fruit Cooperative for distribution to banana growers during the period from February to June this year.

22. According to the result of shooting survey, banana production season this year was predicted to be delayed and the average bunch weight was lower than that of 1998/1999 season, due to the influence of low temperature in December 1999. The bunch weight of banana plants harvested between February and May was 10% lower than the corresponding period of last year. The total production in Kaohsiung and Pingtung area during the period from January to July 2000 was estimated at 2.5 and 2.47 million carton (12.6 kg/carton), respectively.

23. Based on the disease forecast information, large-scale fungicide air spray and ground spray for the control of foliar diseases was carried out 8-11 times between July and November 1999. Disease severity survey made in December 1999 revealed that the banana plants at shooting stage had retained more than nine healthy leaves in the sprayed areas, indicative of a satisfactory control. To promote banana production and improve fruit quality, many demonstrations and lectures for banana growers were held in collaboration with the Fruit Cooperative. A total of 1,900 banana growers attended the meeting this year.