IMPROVING PRODUCTION AND QUALITY OF SELECTED TROPICAL FRUIT THROUGH BREEDING AND MANAGEMENT

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Abstract

The improvements of breeding and management of pitaya, wax apple, Indian jujube and papaya in Taiwan are presented. The pitaya has been introduced into Taiwan more than 300 years and become a potential crop until the large fruit variety introduced from Vietnam in 1990. The hybrid between white flesh variety from Vietnam and red flesh varieties from Central American by growers improved the yield and quality and consequently further transferred the varieties and production techniques to nearby countries. Wax apple is native in Malaysia and become important crop after the forcing season techniques developed in Taiwan. The improvement of quality by management including fruit-thinning, bagging and season regulation make industry developed rapidly. However, the production area declined to about 3000 hectare in the past two decades due to complicated management and dramatic weather changes in the winter. Development of simplified management and stable variety may be required for wax apple. For Indian jujube. Kaohsiung District Agricultural Research Experiment Station has recently released 12 varieties with a common trait of shortened juvenile stage. And production of Indian jujube under net effectively controls fruit fly. Fruit-thinning and appropriate fertilizer application further improve the fruit size to more than 100 gram per fruit. The hybrid F₁ papaya varieties were first developed in Taiwan, and several varieties that are tolerant to ring spot virus were released in the past decades. Production in the net has been applied more than 20 years to protect from the infection of ring spot virus transferred by aphid. Vegetative propagation by cutting, grafting and tissue culture is well conducted to make sure the planting of hermaphroditic young plants in the field.

Keywords: breeding, management, production, quality, pitaya, wax apple, Indian jujube and papaya.

Introduction

Good variety and cultural management are main factors affect the yield and quality in tropical fruit production. Most tropical fruit varieties derive from traditional breeding and some of them have been selected for decades or hundred years and well adapt to local condition. The breeding methods do not change very much in the past decades. However, molecular techniques are well applied progressively to improve the efficiency in fruit breeding. Some delicate breeding methods such as F₁ hybrid have been applied in papaya to protect the owner’s right (Ke and Yen, 2013). Genetic modified variety is not permitted in several countries such as Taiwan and Japan. Meanwhile, the breeding goals shift as well to fit requirement of industry. The release
of pineapple varieties with better quality for table use in Taiwan is a good example for the change of breeding goal from processing to fresh market.

The improvements of management in tropical fruit production are significant. Forcing culture for season regulation has been well applied in most important fruit crops such as mango, wax apple, sugar apple, carambola and durian (Nakasone and Paull, 1998). Delicate orchard techniques including bagging, fruit-thinning, pruning, fertilizer application are conducted to improve the quality. The fruit size and sweetness are much improved by the fine management. The improvements of breeding and management of pitaya, wax apple, Indian jujube and papaya in Taiwan are presented.

**Breeding and Managements of Selected Tropical Fruit Crops**

**Breeding and management of pitaya**

Pitaya has been introduced into Taiwan more than 300 years and become a potential crop until the large fruit variety introduced from Vietnam in 1990. The hybrid between white flesh variety from Vietnam and red flesh varieties from Central American by growers improved the yield and quality and consequently further transferred the varieties and production techniques to nearby countries (Yen, 2012). Large fruit with various flesh color and self-compatible varieties have been released in Taiwan and Vietnam (Fig. 1). The breeding of variety with day neutral and year round production is in progress. The hybrid among genus and species will further improve the quality, production and season.

Season regulation by physical (lighting and pruning), chemicals and varieties have been applied in Taiwan, Vietnam, Malaysia and southern China (Jiang et al., 2012; Yen, 2012; Zee et al., 2004). Development of stable and safe methods need more research. Improvement of quality by pollination, bagging, fertilizers and irrigation are well conducted as Fig. 2 (Yen, 2012). However, more and serious diseases and pests have hampered the potential pitaya industry in Malaysia and other countries (Liao et al., 2003). Pest management needs more attention and further study.

**Breeding and management of wax apple**

Wax apple is native in Malaysia and spread to most tropical and subtropical area. However, it becomes an important crop only after the forcing season techniques developed in Taiwan around 1975 (Wang, 1991). The variety diversity of fruit color, size, shape sweetness and texture are distinct among Southeast Asia countries. The breeding including variety collection and control pollination has been conducted at National Pingtung University of Science and Technology, Taiwan, more than 5 years (Fig. 3, Lai et al., 2013; Liao and Yen, 2006). The study indicated various and potential progeny are derived for its short juvenility (2-4 years) and wide diversity among fruit characteristics (Lai et al., 2013). The variety with stable performance of fruit color and quality are selected for simplified and low-input management (Ke and Yen, 2013).

The improvement of quality by management including fruit-thinning, bagging and season regulation make industry developed rapidly. The development of forcing techniques in wax apple in Taiwan is Fig. 4. However, in Taiwan, the production area dropped about 3000 hectare in past two decades for complicated management and dramatic weather changes in the winter. Regular application of fertilizer either by field
or leaf spray, plant growth regulators, pruning, fruit-thinning, and bagging are conducted almost every week. It increases the production cost and labor in management. Development of simplified management and stable variety by breeding may be required for wax apple.

**Breeding and management of Indian jujube**
Indian jujube is native in India, Myanmar and southern China and widely cultivated in Southeastern countries. The varieties released rapidly for the short juvenile stage and more than 12 varieties have been developed by Taiwan's Kaohsiung District Agricultural Research Experiment Station (Chiou and Yen, 2013). The fruit size and quality improved by breeding is significantly. The season is extended from winter to summer by pruning and fertilizer management in northern Thailand. Production under net has been conducted to protect from fruit fly in the orchard (Fig. 5). The managements of fruit-thinning and fertilizer application further improve the fruit size significantly to more than 100 gram per fruit (Ke et al., 2007, Fig. 6).

**Breeding and management of papaya**
Papaya is an important tropical fruit crop and widely cultivated in tropical and subtropical area. International trade of papaya to temperate countries is important and increasing dramatically. Traditionally, papaya variety is multiplied by seedling from self-pollination. The hybrid F₁ papaya varieties were first developed in Taiwan to maintain superior characteristics and protect breeders’ right (Lee and Wang, 2013, Fig. 7). They are wild cultivated in important papaya production countries. Ring spot virus is most serious disease and widespread in most production area. Several varieties tolerance to ring spot virus by traditional breeding were released in past decades. Production in the net has been applied more than 20 years to protect from the infection of ring spot virus transferred by aphid (Fig. 8). However, the cost of net and maintenance of management are relatively high as compared with field. Bending and pruning have been developed to control papaya height in the net. The plant can be maintained in the net for ten years without replanting (Fig. 8). The sex ratio of young seedlings is varied with parents. One-third female is derived and frequently removed by growers in the orchard. Vegetative propagation by cutting, grafting and tissue culture is well conducted to make sure the planting of hermaphroditic young seedlings in the field. Variety with all hermaphroditic seedlings was released as Tainung No. 7 in Taiwan (Chiu et al., 2003). However, it is still waiting for commercial production.

**Conclusion**
The development of variety and management is important in improvement of quality and yield in tropical fruit production. Breeding by traditional methods and assisted by new techniques will promote release of new variety. The modification of breeding goals to fit market requirement are necessary as well. The products for multiple and wide use will be more acceptable by consumers. However, on the contrary, the management should be simplified to reduce the cost, chemical residues and energy consumption. The combination of breeding and management will be beneficial to improve the production and quality which in turn will be further feasible to lower the cost and input in tropical fruit industry.
References


Fig. 1. The variation of pitaya fruit collected at National Pingtung University of Science and Technology, Taiwan.
<table>
<thead>
<tr>
<th>Two layers on single pole</th>
<th>Fruit exhibition</th>
<th>Forcing flower by lighting</th>
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<td>One layer and Single pole</td>
<td>Flower for vegetable</td>
<td>Fruit bagging</td>
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Fig. 2. The study to improve yield and quality of pitaya conducted in Taiwan.
Fig. 3. The variety collected and hybrid clones selected in wax apple breeding program at National Pingtung University of Science and Technology, Taiwan.
Fig. 4. The development of forcing techniques in wax apple.

Fig. 5. The production of Indian jujube in the net to protect from fruit fly.
Fig. 6. The increase of fruit size by variety and management such as fruit-thinning and fertilizer application.

Fig. 7. F1 hybrid variety ‘Tainung # 2’ (bottom left) derived from ‘Thailand’ (top right) from Thailand and ‘Sunrise’ (bottom right) from Hawaii.
Fig. 8. Papaya production in the net (top) for protection from ring spot virus and bending pruning (bottom) to control plant height.