Three Decades of Breeding Golden Camellia Varieties in Nanning Golden Camellia Park

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Abstract: Since 1982, the breeding work in the Golden Camellia Park has followed an arduous path. The paper introduces the main techniques and achievements in the past three decades including the breeding goals, main approaches and technological measures, and discusses current affecting factors and prospects for further breeding.

Keywords: Yellow Camellia; Hybridization; Breeding; Three decades

The Yellow Camellia is a world famous rare ornamental plant, known as the ‘Giant Panda of Plants’ and ‘Queen of Camellias’, and is a rare flower unique to our country. Since it was discovered in Guangxi in the 1960s, it has caused a sensation in the horticultural sector of the world. A lot of camellia breeding enthusiasts tried to use the yellow gene to breed new varieties of camellia, and Professor Cheng Jinshui and Chen Junyu from Beijing Forestry University tried to cooperate with Kunming Institute of Botany, from the beginning of 1973 in Kunming. We also conducted hybridization with Yunnan camellias (C. reticulata) as mother parents and yellow camellias as pollen parents, but unfortunately there was not one yellow flower that appeared in the past ten years. By the end of 1980, the two professors came to Guangxi to continue hybridization work, and they made artificial pollinations of hybrid yellow camellia as female parents, together with Yunnan camellias, Camellia japonica and Camellia sasanqua as male parents. Nanning Golden Camellia Park has conducted breeding and reproduction work on yellow camellias for 30 years, with the guidance of Chen Junyu, Cheng Jin, Li Tianqing, Deng Zhaozuo, Zhang Xinsi, Yutada Hiroshi, Li Daomei, Mo Shuye, Huang Liandong and other scholars and experts, and have completed distant hybridization in six villages, Lvdeng mountain, Dadeng mountain and other tropical forests.

1 Breeding Goals

It was decided to pursue the following breeding goals: breeding for large sized yellow flower varieties; breeding for yellow star-like flower form varieties; breeding for great tolerance in extensive management, drought, disease and pests; breeding for fragrant Golden Camellia varieties. We conducted artificial pollination work in the natural habitat of yellow camellias, but the management of the project was very hard due to the long distances involved and because of artificial destruction factors, we harvested very few hybrid fruits.

In 1982, a yellow camellia gene pool (the former Xinzhu nursery) was established in Golden Camellia Park in Nanning city, and we can conduct distant hybridization and breeding work in the gene pool. After years of effort, hybrid seedlings are now starting to bloom. We have successfully developed several yellow camellia varieties, such as the double yellow camellia ‘Dongyue’, and ‘Jin bei dan xin’ that has red on the surface and yellow on the back of the petal. Some varieties have been registered in the China Camellia Society. ‘Dongyue’ was awarded the New Variety Prize at the Camellia Exhibition held during the 2012 International Camellia Society Congress in Chuxiong.

2 Hybridization Compatibility among species of Sect. Chrysantha

We first attempted artificial pollination with Camellia nitidissima, Camellia euphlebia, Camellia tunghinensis and Camellia chrysantha as female parents, Camellia japonica and Camellia sasanqua as male parents. Over decades, we have gained some experience in conducting pollination.

Firstly, we used style-cover bags instead of conventional flower-cover bags so as to save work after pollination. Secondly, we took various measures to increase fruit bearing rate of pollination: conventional hybridization and induction hybridization: dry or dead pollen and fresh pollen were mixed so as to improve pollen germination as well as promoting incompatibility of pollen tube growth. Mixed fresh pollen was used simultaneously in pollination process, ie, pollen from two species of yellow camellias mixed with pollen from the female parent. Sugar solution
of 10% sucrose was applied to top of *Camellia nitidissima*. We also tried cutting the stigma of *C. nitidissima* 3mm from the ovary and applied the pollen directly to the cut surface so as to enhance fruit bearing rate.

For the last thirty years, from 1982 until now, we have conducted distant hybridization in the gene pool of Golden Camellia Park. A total of 35,514 flowers have been pollinated and we have collected 1268 seeds from 603 hybrid fruits in 230 cross combinations (Table 1).

We found that there was weak compatibility among yellow camellias and other non-yellow camellias due to their low fruit-bearing rate. The main reasons probably resulted from genetic relationship. Another factor was related to climatic condition during period of hybridization. Rain or low temperatures may greatly influence fruit bearing rate. Although we have not obtained fruits in past hybridizations from some cross combinations, the results in Table 1 do not mean that this is impossible and further hybridization should be repeated in future. On the other hand, we have achieved a highly successful hybridization rate among yellow *Camellia* species. For example, three fruits (3.75% success) were harvested from 80 pollinated flowers in a cross between *C. nitidissima* x *C. hakodae*. High fruit bearing rates were also obtained by using mixed pollens, for example, we harvested 40 fruits (14.9%) from 269 flowers of crosses between *C. nitidissima* x (*Qixingbai* (C. *japonica*) + *C. nitidissima* (radiated by γ 3000)). The successful hybridization rate ranged from 6.4% (with *C. reticulata*) to 6.9% (*C. japonica* ‘Shizitou’) in our work, but it is difficult to raise saplings from these hybrid seeds.

### 3 Major Factors to affect successful hybridization

From the table, we summarized the major affecting factors as listed below:

3.1 Distant hybridization: it is difficult to bear fruits due to distant genetic relationship between parents.

3.2 Climate factors: there are some variations in temperature and rainfall each spring and winter in Nanning that greatly influence yellow camellias.

3.3 Differences in individual plant: some individuals bear numerous fruits and some only a few fruit even from quite a quantity of flowers. We should pay more attention on selection of individuals as mother parents.

### 3.4 Hybrids and their variation patterns in major characteristics

We should conduct interspecific hybridization using parents with good traits. For example, *C. tunghinensis* has dense flowers, small leaves and flowers; when it was crossed with *C. nitidissima*, *F*₁ generations show some features much like its mother parent, i.e. dense flowers, but large leaves and flower size. When *C. nitidissima* was used as mother parent to cross with *C. hakodae* from Viet Nam, *F*₁ offspring show their intermediate characteristics between parents, for instance, larger leaves compared to its female parent. Although the hybrid is not flowering yet, we expect larger flowers from it.

Most flowering hybrids only show characteristics from mother side, or only show paternal characteristics. Only a small portion of them present intermediate characteristics between two parents. Finally, we successfully bred double yellow camellia varieties and a series of yellow camellia hybrid varieties, such as ‘Dongyue’, ‘Xinhuang’, ‘Dongmeiyenchun’, ‘Bi Liu’, ‘Jin Bei Dan Xin’, ‘Xin Zi’, ‘Shuimeiren’ as well as ‘Huigui’ and so on. Their photos are presented below:

#### 4 Discussion and Prospects

4.1 In general, most of *F*₁ generation from distant hybridization shows the characteristics of the mother parent, occasionally of the father parent and few intermediate.

4.2 In order to breed large yellow double form camellia varieties, at least one parent should be double form or double hybrid.

4.3 Hybrid seeds usually are small and germinate very poorly. Their saplings grow weakly. Therefore, it is suggested to improve survival rate by normal grafting or combined grafting at early stage.

4.4 It is possible to breed for star-like flower form varieties by interspecific hybridization, such as (*C. tunghinensis* x *C. nitidissima*), which brings new hope in further breeding work in future.
4.5 Based on our experience in past decades, the F₁ hybrids usually show pink or pale yellow color of flowers, but less deep yellow in crosses of *C. nitidissima* and red or white *C. japonica* cultivars. Deep yellow cultivars may be bred by using recurrent hybridization (backcross) or reciprocal hybridization of F₁ or F₂ as parents.

**Literature cited**


The results tables from this paper contain a great deal of information of interest to breeders, and show both positive and negative results. These tables can be found, together with the rest of this paper, on the ICS website.

**Genetic diversity and Relationship among Camellia japonica populations in China and Japan**

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**Abstracts:** *Camellia japonica* (L.) is an important species both in horticultural and economic terms, distributed naturally in China (Zhejiang and Shandong provinces), Japan (Honshu, Shikoku, and Kyushu Islands) and along the southern and western coast of the Korean Peninsula. Inter-simple sequence repeat (ISSR) markers were used to investigate its genetic diversity within and among thirteen natural populations of *C. japonica* in East China and Japan. Leaf samples were collected from 390 individuals. Twenty ISSR primers selected from 80 primers gave rise to 211 discernible DNA bands of which 190 (90.05%) were polymorphic. On average each primer gave rise to 10.55 bands including 9.50 bands with polymorphic profile. At the species level, high genetic diversity was detected (PPB: 90.05%; \(H_e\): 0.3414; \(H\): 0.5013). However, relatively low genetic diversity existed within populations. The population in Shikoku Island (Shiko-2) exhibits the greatest level of variability (PPB: 76.78%; \(H_e\): 0.2966; \(H\): 0.4319), whereas the population in Xiangshan (XS) presents its own variability at the lowest level (PPB: 67.30%; \(H_e\): 0.2344; \(H\): 0.3478). A relatively high level of genetic differentiation among populations was revealed by Nei’s gene diversity statistics (21.27%), Shannon’s information measure (21.38%) and analysis of molecular variance (AMOVA) (22.45%). The main factors responsible for the high level of differentiation among populations are probably related to the isolation of populations, and a significant correlation was found between genetic distance and geographic distance (\(r = 0.8154, P < 0.05\)).