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THE VARIETY OF RESOURCES AND CULTIVATION OF LYCHEE IN CHINA

HONGXANG PENG AND RONGGUANG LIU
Guangxi Academy of Agricultural Science
Nanning 530007, Guangxi, China

JIANG LU¹
Florida A&M University
Center for Viticulture and Small Fruit Research
6505 Mahan Drive
Tallahassee, FL 32317

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Abstract. Lychee (*Litchi chinensis* Sonn.) is a famous and precious fruit cultivated in tropical and subtropical regions of the world. It is originated from southern China where there is a long history of cultivation for this fruit. China, as the first country with domestic culture of lychee in the world, has various ecological environments suitable for lychee production. They are scattered from low latitudes in the southern part of Hainan Island to the high latitudes of Yibin prefecture of Sichuan Province. They are also distributed from below sea level in the Pearl River Delta of Guangdong province to 1100 to 1400 meters above sea level near the Jinshajiang River in Yunnan Province. Many lychee varieties that are adapted to different environmental conditions were selected during the past several thousand years and came from different ecological conditions. China has very rich lychee resources, and various cultivars range from early, middle, to late season of ripening. More than 200 lychee cultivars have been grown in southern China.

Origins and Classification of Lychee Varieties

The Ecological Characteristics of Original Areas and Wild Lychee Resources

Lychee, from wild to domestic, formed its unique ecological characteristics through its long evolutionary history. It needs high temperatures and high humidity for fruit development and vegetative growth, and a cool winter and dry climate for floral bud differentiation and flower initiation. Lychee mainly grows in the sub-tropical region of south China, including the central and southern parts of Guangdong and Guangxi, southeastern Fujian, and the central and southern parts in the west coast of Taiwan. The climates in these areas are sub-tropical with a cool winter and hot and humid summer. Annual rainfall ranges between 1000 and 2600 mm. Rain occurs mainly in the spring and summer, with cool fall

and dry winter periods, which are ideal conditions for lychee growth. Average annual temperatures in the lychee growing areas are between 20 to 30 °C. In the coolest month of January, average temperatures are between 10 to 14 °C. There are more than 300 d per year with daily average temperatures equal to or greater than 10 °C. Frost ranges from 1 to 5 d in most years (Wu, 1998). Soils are mainly laterite and red loam. Yellow soil, red loam and laterite are vertically distributed in the hilly areas with high temperatures in these soils. The organic content in the soil surface is 1%-2%. Vegetation in these areas is tropical and sub-tropical forests.

Lychee originated from the Southern China where rich wild lychee germplasm exists (Xu et al., 1964). Wild lychee trees are still preserved in the central/southern part of Hainan Island (Fu and Yuan, 1983). The wild lychee bears many shapes of fruits such as round, ellipse and spindle. Most wild lychee trees are tall with strong roots, but the fruits are small. The skin segments vary in size and are irregularly arranged. The flesh is thin and tastes sour. It is difficult to separate the flesh from the seed.

Classification of Lychee Varieties

Classification of lychee varieties relies mainly on morphological characteristics. It is generally accepted that classification of lychee varieties should use more stable/inheritable features such as skin segments and segment shapes. Based on the characteristics of skin segments and segment shapes, the lychee varieties in China can be divided into three groups (Wu, 1998): sharp-pointed skin segments, protuberant skin segments, and smooth skin segments.

Sharp-pointed skin segments. The main characteristics in this group are obvious projecting skin segments, most of which are pyramidal or sharp-pointed. The tops of the segments range from sharp pointed to short pointed and wedged-pointed. There are 39 major varieties in this group: Babaoxiang, Chenzi, Dashugong, Dazao, Feizixiao, Guangzi, Guihuahong, Guilin, Guiwei, Hainancuirou, Hejiangnuomici, Hongqiu, Huidongsijili, Huoshaoben, Jinhong, Laoguanren, Luhebao, Maoguzi, Shanyuanhong, Minhoushanzhiximian, Panguzi, Pu, Putianbailizi, Quanzhouzaohong, Shuijingqiu, Siliangguo, Songxiang, Suzhouli, Waidi, Wuheli, Xiaohan, Xihezhi, Yuanhong, Yuqilin, Zaohong, Zengchengcuirou, Zhuheli, Zhumunai, and Zhuyezhong.

Protuberant skin segments. This group of lychee varieties is characterized by protuberant skin segments. The segments can be sharp-pointed, wedged-pointed, hair-pointed, short-pointed, or slightly swelling. There are 111 main varieties in this type: Aniangxie, Baisali, Baitangli, Beiliuzhenfeng, Bianzi, Bixiang, Bobaitangbo, Budai, Cangwubaila, Chanchutou, Conghuaxiangli, Dadingxiang, Darou, Datianma, Dianbaibaila, Dianbaitangbo, Dingxiang, Dongliu 1, Doulizhi, Edanli, Fengchuiliao, Fengtangguo, Fuyu, Goubei, Guangxilongli,

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¹Corresponding author.

Guangzhouqingpi, Heimia deng, Hejiangfeizixiao, Hepuqingpi, Hepusijili, Hepuwumian, Hongheniang, Huakeli, Huangdijiu, Huangniugo, Huangyeli. Huiantongzi, Huiguo, Huoshanli, Jianglizhi, Jiangyeli, Jiaoerhuan, Jidi, Jiguizi, Jiluanquo, Jingeng, Jingangchui, Jinke, Jinzhong, Jinzhongzi, Jiulixiang, Jizuili, Kengtouwuye, Lingshanxiangli, Liuyuexue, Lizi, Longli, Longyanben, Luchuanjiangjunli, Luluopao, Luzhouhebaoli, Mabing, Maquechun, Meiguilu, Mengtianshanzhi, Minhoushanzhibaimi, Minhoushanzhichangsuo, Minhoushanzhihanke, Minhoushanzhilongyanzi, Minhoushanzhishizuan, Nanhai, Nanmuye, Nuomici, Nuomishanzhi, Pubezhenfeng, Qingpitian, Qingtangli, Qingtian, Qingtiannuo, Qiyueshu, Quanzhougongzi, Quanzhouzhuangyuanheng, Shangshuhuai, Shuinang, Shuixishanzhi, Siyueshu, Suanhuzi, Tangbo, Tasiniu, Tianjiazi, Tianyan, Xiafan zhi, Xiafan zhibaimi, Xiafan zhilongyanben, Xiafazhiwanshuzhong, Xiangzhi, Xiaodingxiang, Xihebao, Xijiaozhi, Ximili, Xinxingxiangli, Yanalong, Yin zhan, Yuhebao, Zaoguangdong, Zengchengjinfeng, Zhangluoli, Zhongshanzhuangyuanhong, Zhuangyuanhong, and Zhukouwuye.

Smooth skin segments. The key characteristics of this group are smooth skin segments. Some may be slightly swollen with a minor protuberance. There are 56 major varieties in this type: Baihai, Baitangying, Baiye, Bingrangli, Cengtuo, Chiguangdong, Chiye, Daguo, Dahebao, Dahongtuan, Daniugu, Dongcuolizhi, Dongqiang, Edanhuang, Gangwei, Guahong, Gualu, Heiye, Hongli, Hongmudan, Huaixhi, Huianwumian, Huianhebaoli, Jiangjunli, Jiangkouli, Jianjianghongnuo, Jiefanghong, Juehuaizi, Lanzhu, Liqui, Lusha, Magonghao, Malingli, Mamili, Qingke, Qingkewuye, Rongxianbaila, Sanyuehong, Shakengzhong, Shuili, Siyueli, Songjiaxiang, Tangwei, Tianuan, Tongshachihuaizhi, Wanfengxiaohu, Wupao, Wusuzi, Wuyejiu, Xinmenlouchihuaizhi, Xuehuaizi, Yanzhihong, Yuanzhi, Zaoheiyue, Zengchengsijiguo, and Zhongshanbaila.

Distribution of Lychee

Geographic Distribution of Lychee

Lychee was spread from China to Burma, India and Jamaica at the end of 18th century, and then to the United States in the 19th century. Lychee is currently cultivated in many countries in the world, such as India, Thailand, Vietnam, Burma, Bangladesh, Cambodia, Laos, Malaysia, Philippines, Sri Lanka, Indonesia, Japan, Israel, South Africa, Mauritius, Madagascar, Gabon, Congo, Australia, New Zealand, United States, Honduras, Panama, Cuba, Puerto Rico and Brazil (Lin and Lu, 1993).

Lychee has been cultivated in China for more than 2,200 years. It has been widely distributed in China from north latitude 18° to 30° and east longitude 97 to 120°, with heavy commercial production in several provinces from latitude 21°30' to 24°30'N, east longitude 106° to 121° (Wu, 1998). It was estimated that the total growing area of lychee in China was more than 0.55 million hectares in 1999, with a total yield of 1.27 million tons. In terms of production in provinces, Guangdong ranks number one, followed by Guangxi, Fujian, and Taiwan which has the highest yield/hectare.

Guangdong Province

Lychee is distributed in most counties of the province. But the commercial production is concentrated in the following

cities and counties: Guangzhou, Dongguan, Huaxian, Conghua, Dianbai, Shenzhen, Zhongshan, Zengcheng, Huazhou, Huilai, Xinhui, Puayu, Xinxing, Sihui, Luoding.

Guangxi Province

More than 80 counties produce Lychee, but most orchards are located in Qinzhou, Yulin, Guigang, Nanning, Wuzhou cities and Nanning prefecture. The largest growing areas are found in Qinbei district of Qinzhou, Beiliu and Guiping.

Fujian Province

Lychee cultivation is scattered in 37 counties in the south and the southeast of Fujian Province but orchards are mainly located in Longxi and Jinjiang prefectures. Large production is found in Longhai, Zhangpu and Zhaoan counties.

Hainan Province

Every county of Hainan province harvests lychee, but the main producing areas are located in Qionghai, Wenchang, Zhanxian, Qionghai, Anding, Lingao, Chengmai, Haikou, Tunchang, and Baisha counties.

Sichuan Province

Sichuan Province has a long history of Lychee production in China. The province cultivated lychee as early as the Tang Dynasty. The plantations of lychee have been reduced since the 17th century. In the 1980s, Lychee was growing in Hejiang, Luzhou, Naxi Jiangnan, Yibin, and Pingshan counties, but only the Hejiang and Luzhou counties have commercial production.

Taiwan

Lychee is scattered in the entire Taiwan island, with major commercial production in Pingdong, Jiayi, Zhanghua, Nantou, Taizhong, Miaoli and Xinzhu counties.

Other Regions

Lychee is also distributed in some counties of Yunnan, Guizhou and Zhejiang provinces and Chongqing Metropolitan Statistical Area (MSA) (Fu, 1986). Lychee can be found in Malipo, Mengzi, Kaiyuan, Xiping, Jinghong, Hekou and Yangjiang counties of Yunnan Province, and in Chishui, Xishui, Wangmo, Ceheng and Luodian counties of Guizhou Province. Lychee is also sparsely scattered in Jiangjin, Beiling, Changshou, Wanxian and Yunyang counties of Chongqing MSA. Lychee was introduced and cultivated in Cangnan and Pingyang counties of southern Zhejiang province twenty years ago.

Lychee Cultivars

China has rich lychee resources and diverse lychee varieties. Some lychee varieties have fruit weighing up to 50 grams, while others have tiny seeds. Quality, shelf life, and yield vary among these varieties.

Table 1 lists the most common lychee cultivars cultivated in China. Early maturing cultivars include Sanyuehong and Baitangying; middle-early maturing cultivars consist of Baila, Feizixiao and Shuidongheiyue; medium maturing cultivars are

Table 1. Major cultivars and productions of lychee in China.

Cultivars	Area (10,000 ha)	Yield (10,000 ton)	Ripening	Main cultivated area
Huaizhi	20.0	48.1	early July	Guangxi, Fujian, Guangdong
Heiye	6.7	18.4	mid-June	Taiwan, Fujian, Guangdong, Guangxi
Feizixiao	2.3	6.3	late May	Hainan, Guangdong, Guangxi
Baitangying	2.1	4.8	late May	Guangdong, Guangxi, Hainan
Xiangli	2.0	3.6	late June	Guangxi, Guangdong, Fujian
Guiwei	1.7	2.9	late June	Guangdong, Guangxi, Fujian
Noumici	1.3	2.1	late June	Guangdong, Guangxi, Fujian
Sanyuehong	1.0	2.4	mid-May	Guangdong, Guangxi, Hainan
Dazao	0.6	1.5	early June	Guangdong, Guangxi

Dazao, Heiye, Tianyan, Chenzi, Jizuili, Xiangli, Guiwei, Noumici and Tangbo; and late maturing cultivars comprises Huaizhi, Xuehuaizi, Lanzhu, Yuanhong, Xiafanzhi and Nanmuye.

Cultivation of Lychee

The key for a young lychee orchard is to manage the canopy, fertilizer, pest and disease. Young lychee trees are pruned to form a strong tree structure with 3-4 main limbs, even branches, and a semi-dome canopy. Cover crops such as legumes are usually grown between trees. During the first four years, cover crops, compost, straw and barnyard manure are buried between and within rows each year to improve soil fertility. Mulching around lychee trees with straw can reduce water loss and minimize temperature fluctuations around the roots. Young Lychee trees are fertilized lightly and regularly to allow root development and strong shoots. Nitrogen, phosphorus, and potassium fertilizers are used as the main source for nutrition. Micronutrients are used as a supplement.

Lychee sting-bug (*Hypomeces squamosus* Fabricius), lychee moth (*Thalassodes quadraria* Guenee), lychee beetle (*Anomala corpulenta* Motsch), lychee wax moth (*Lawana imitata* Melichar), lychee bug (*Tessaratomapa pollosa* Drury), lychee tree borer (*Aristobia testudo* Voet), lychee wood moth (*Arbele dea* Swinhoe), and lychee thrips (*Scirtothrips dorsalis* Hood) are the major insects that cause damage to leaves, bark, shoots and trunks of young lychee trees. Anthracnose, sooty mold and lychee downy mildew are the common diseases found on young lychee trees. When young fruit turn yellow, lychee downy mildew, lychee sooty mold and lychee stem end borer (*Conopomorpha sinensis* Bradley) are the common problems that should be controlled. When fruit color is changing to red, lychee beetle (*Oxycetonia jucunda* Falder-

mann), lychee weevil (*Xylotrupes gideon* Linnaeus) and fruit bat can cause problems.

The management strategies for bearing trees focus on nutrition, culturing strong bearing branches, controlling winter shootings, inducing flower buds, increasing fruit set by assisting pollination, and controlling pests and diseases. Fertilizers should be applied according to the nutritional needs in different developmental stages. For example, it has been suggested in Guangdong province that 1.38 kg N, 0.8 kg P₂O₅, and 1.5 kg K₂O are needed for a 30-year old tree to produce 100 kg of fruit.

Strong bearing branches are essential for a good yield. The standard of strong bearing branches for Sanyuehong, Baitangying and Baila, for example, is 25 to 35 cm long and larger than 0.45 cm in diameter at maturation in the fall. Controlling winter shoot growth and stimulating flower bud initiation is important to ensure sustainable productivity. Ethephon +B9 (damircoyide) is used to control shoot growth in the winter. Girdling, root pruning, and other practices are used to stimulate flower bud initiation. Bees are released in the orchard during anthesis to increase fruit set by improving pollination.

Total soluble solids, titratable acidity and taste are commonly used to determine fruit maturity. When fruits ripen, harvesting should be carried out immediately.

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