

早熟柑橘新品种仁选早柑的选育

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摘要:仁选早柑是从贡柑田间优选单株中获得的早熟柑橘新品种。在韶关地区种植, 11月上中旬成熟, 较贡柑早熟近1个月。果实近球形, 平均单果质量78.07 g, 果形指数为0.84, 果皮黄橙色, 较易剥皮, 囊瓣整齐, 果肉中等橙色, 脆嫩化渣。果实可溶性固形物含量(w, 后同)为14.0%, 维生素C含量(ρ)为356 mg·L⁻¹, 总酸含量为0.52%, 总糖含量为11.2%。对黄龙病不具抗性, 易感褐斑病。丰产性好, 5年生树产量18 750~37 500 kg·hm⁻²。

关键词:柑橘; 新品种; 仁选早柑; 早熟

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A new early-ripening citrus cultivar Renxuanzaogan

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Abstract: Gonggan is a local characteristic mandarin variety in Guangdong with a cultivation history of over 1100 years and a total cultivation area of approximately 26 667 m². Breeding early maturing citrus varieties can solve the problem of inconsistent market quality caused by early harvest of citrus, and also avoid excessive concentration of market periods. In September 2017, Renxuanzaogan was found in an orchard where Gonggan was cultivated, in Renhua County, Shaoguan city by the Fruit Research Institute of the Guangdong Academy of Agricultural Sciences, Shaoguan University, Shaoguan Agricultural Science and Technology Extension Center, and Renhua County Agricultural and Rural Development Service Center. After three consecutive years of observation on biological characteristics, it was proved that its maturity period was one month earlier than the control Gonggan, with significant and stable differences existing. The certificate of Plant New Variety Rights was issued by the Ministry of Agriculture and Rural Affairs in 2023 (CNA20201005931). As is similar to the control variety Gonggan, this variety is susceptible to citrus huanglongbing and citrus brown spot disease. The tree posture of Renxuanzaogan is open. The spring shoots have short spines, with a length of 0.10 cm. The leaf blade is broadly lanceolate, with wavy edges, leaf shape index of 2.07, petiole length of 0.85 cm, and narrow winged leaves. The flower is white with 5 petals, 1.32 cm in length and 0.59 cm in width, and 13–16 filaments, partially united. The anthers are light yellow, and the style is arched, higher than the stamens. The fruit is nearly spherical, with a single fruit weight of 78.07 g and a fruit shape index of 0.84. The fruit sur-

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face is glossy, with flat oil cells. The fruit skin is yellow orange, with a thickness of 0.15 cm, which is easy to peel off. The core is semi-plump, and the segments are semi-lunar and neat. The segment membrane is thin and easy to separate, and the juice sacs are compact and spindle-shaped. The flesh color is uniform, with a medium orange color. The fruit edible rate is 73.86%, the fruit juice content is 48.89%, the soluble solids content is 14.0%, the total acid content is 0.52%, the total sugar content is $112 \text{ g} \cdot \text{kg}^{-1}$, and the vitamin C content is $356 \text{ mg} \cdot \text{L}^{-1}$. The number of seeds per fruit is 3–10, with wedge-shaped seeds, white cotyledons, and multiple embryos. There is a significant difference in the genome between Renxuanzaogan and the control of Gonggan. Compared with the genome of Clementine, Renxuanzaogan was identified as 2 874 326 SNPs and 588 506 InDels, while Gonggan was identified as 2 726 005 SNPs and 579 333 InDels. The differences in SNPs and InDels between Renxuanzaogan and Gonggan were 881 840 and 172 838, respectively, accounting for 32.35% and 29.83% of the total SNPs and InDels identified in Gonggan. This variety is suitable for cultivation in Gonggan cultivation areas with an annual average temperature of over 20 °C in Guangdong and Guangxi. Seedling breeding can use rootstocks such as trifoliolate orange (*Poncirus trifoliata* Raf.), Suanju (*Citrus reticulata* Blanco), and Xiangcheng (*C. junos*). Planting disease-free container seedlings in new orchards can accelerate the formation of high-yield tree shapes. It is very important to prevent and control citrus huanglongbing. It is necessary to control the transmission of pests, such as citrus psyllid, whitefly and aphid during the shoot emergence period in spring, summer and autumn. When the temperature is between 20 °C and 28 °C, the prevention and control of citrus brown spot disease is priority during the shoot emergence period in the rainy season.

Key words: *Citrus*; New cultivar; Renxuanzaogan; Early-ripening

贡柑是广东省本地农家种。史料记载,在广东省四会市从唐代就有贡柑种植,距今1100多年^[1]。目前,在广东德庆、仁化及广西钟山等地,贡柑是主栽品种,总面积约2.67万 hm^2 ,是当地果农主要收入来源。

贡柑果实近球形,果皮橙黄,果肉淡橙色,较易剥皮。11月上中旬进入果实转色期,此时果肉清甜,完熟后蜜味浓。受近年柑橘市场逐渐饱和的影响,多数本地主栽品种如砂糖橘、红江橙等均在12月中旬开始集中上市,柑橘售价出现下滑。贡柑因转色期(市场称为“青果”)可上市,较其他中熟柑橘品种价格稍高。但“青果”随着贡柑成熟期的变化,品质极不一致,影响市场对贡柑的消费信心,打压后续上市成熟且优质贡柑的效益。现有基于芽变选种的柑橘品种多集中于无核性状,如华柑四号^[2]等。同样,贡柑品种,如华蜜无核贡柑^[3]、无籽贡柑^[4]等也多集中于无核或少核性状,未见成熟期较贡柑提前的品种。因此,选育出早熟贡柑品种显得尤为重要,是解决“青果”上市品质不一的有效手段,也是避免上市期过于集中的有效途径。

1 选育过程

2016年开始,广东省农业科学院果树研究所与韶关学院、韶关市农业科技推广中心、仁化县农业农村发展服务中心在韶关市联合开展贡柑优异单株筛选。2017年9月在韶关市仁化县下营村果园内发现一单株(编号G20170922)的果实较贡柑早转色,即取其枝条与对照贡柑枝条同时嫁接于酸橘砧上。2018年4月将贡柑及单株G20170922种植于发现单株的同一果园内,2020年开始结果,同时按照《植物新品种特异性、一致性和稳定性测试指南 柑橘》(NY/T 2435—2013)开展田间测试。经过连续3 a(年)生物学特性观察记录,单株G20170922果实膨果期早、较贡柑早熟特性稳定,定名仁选早柑,2023年获得农业农村部颁发的植物新品种权证书(CNA20201005931)(图1)。

2 主要性状

2.1 植物学特征

树冠近圆形,树姿开张。春梢节间长度1.40 cm,



图 1 早熟柑橘新品种仁选早柑

Fig. 1 A new early-ripening citrus cultivar Renxuanzaogan

部分具短刺,刺长 0.10 cm。叶片阔披针形,波状缘,叶形指数 2.07,基部楔形,尖端渐尖具缺刻,叶柄长 0.85 cm,翼叶窄。花白色,花瓣 5 枚,长 1.32 cm,宽 0.59 cm,花丝 13~16 条,部分联合,花药淡黄,花柱弓状,高于雄蕊。

2.2 物候期

在韶关,该品种 3 月上旬春梢抽发,3 月上中旬开花,5 月上中旬第一次生理落果,5 月中下旬夏梢抽发,8 月上中旬秋梢抽发,果实 9 月下旬至 10 月上旬转色,11 月上中旬成熟。丰产稳产,5 年生树产量 18 750~37 500 kg·hm⁻²。

2.3 生长结果特性

果实近球形,平均单果质量 78.07 g,果形指数 0.84,果基圆形,果顶平,乳突不明显,果面有光泽,油胞平,果皮黄橙色,厚度 0.15 cm,较易剥皮,果心半充实,囊瓣半月形,整齐,9~12 瓣,囊壁薄,较易分离,汁胞紧实,纺锤形,果肉颜色均匀,橙色,脆嫩较渣。可食率 73.86%,果汁含量(w,后同)为 48.89%,可溶性固形物含量为 14.0%,总酸含量为 0.52%,总糖含量为 11.2%,维生素 C 含量(ρ)为 356 mg·L⁻¹(表 1)。单果种子数 3~10 粒,种子楔形,子叶白色,多胚。

表 1 果实性状与熟期性状差异

Table 1 Differences in fruit traits and fruit maturation period

品种 Cultivar	w(可溶性固形物) Soluble solid content/%	w(总糖) Total sugar content/%	w(总酸) Total acid content/%	ρ(维生素 C) Vitamin C content/(mg·L ⁻¹)	w(果汁) Juice content/%	单果质量 Fruit mass/g	成熟期 Maturation period
仁选早柑 Renxuanzaogan	14.0	11.2	0.52	356	48.89	78.07	11 月上中旬 Early-mid Nov.
贡柑 Gonggan	14.3	11.3	0.61	300	47.35	69.37	12 月上中旬 Early-mid Dec.

2.4 抗逆性

连续 3 a 区域试验表明,与对照品种贡柑一样,该品种易感黄龙病,对褐斑病敏感。在网棚设施内栽培时,其产量较贡柑稳定。

3 全基因组重测序及分子鉴定

3.1 全基因组重测序

提取贡柑、仁选早柑基因组 DNA,送北京百迈客生物科技有限公司(Biomarker Technologies)采用 Illumina 测序平台进行高通量测序,测序深度为 10X,

以克里曼丁橘(与贡柑同为橘橙杂交种)为参照,与克里曼丁橘基因组比较,仁选早柑鉴定出 2 874 326 个 SNPs,588 506 个 InDels,贡柑则鉴定出 2 726 005 个 SNPs,579 333 个 InDels(表 2)。仁选早柑与贡柑二者间差异 SNPs、InDels 分别为 881 840 个、172 838 个,分别占贡柑鉴定出 SNPs、InDels 总数的 32.35%、29.83%。可见,仁选早柑与对照贡柑基因组间差异大。

3.2 仁选早柑与贡柑的 SSR 分子鉴定

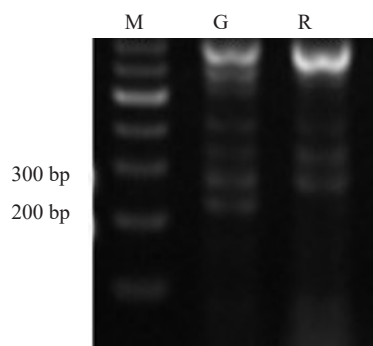
提取仁选早柑与贡柑 DNA,采用 SSR 方法并参照郭雁君等^[5]的报道,引物为 CMS30: F(5'-AA-

表 2 贡柑、仁选早柑全基因组差异

Table 2 Genome differences between Gonggan and Renxuanzaogan

样品 Samples	单核苷酸多态性 Single nucleotide polymorphism, SNP	小片段的插入 与缺失 Small insertion and deletion, InDel	基因组结 构变异 Structural variation, SV
贡柑 Gonggan	2 726 005	579 333	9099
仁选早柑 Renxuanzaogan	2 874 326	588 506	8052

CACCCCTTGGAGGGAG-3'), R(5'-GCTGTTCA-CACACACAACCC-3')。如图 2 所示,在 200~300 bp 之间,仁选早柑与对照贡柑 PCR 产物电泳条带差异明显。



M. DNA marker; G. 贡柑; R. 仁选早柑。

M. DNA marker; G. Gonggan; R. Renxuanzaogan.

图 2 仁选早柑与贡柑引物 CMS30 PCR 扩增产物
Fig. 2 Amplification of Renxuanzaogan and Gonggan
by primer CMS30

4 栽培技术要点

4.1 适栽区

该品种适宜在广东、广西年均温 20 °C 以上的贡柑种植区域种植。建园应选择水源丰富的缓坡地,避免在低洼湿润的小盆地区域种植。为延缓柑橘黄龙病的传播,优选周边无九里香、柑橘等芸香科植物种植的区域建园,或设置适当的防风林或防风带。苗木繁育可使用枳、酸橘、香橙等作砧木。新建果园种植

无病容器大苗可加速形成丰产树形,获得经济产量。

4.2 水肥管理

幼龄树施肥应勤施薄施,促成树冠。成年树在夏梢抽发期加强树体营养管理,避免落果。

4.3 病虫害防治

做好柑橘黄龙病防控,并在春、夏、秋梢抽发期做好传病虫媒介柑橘木虱、粉虱及蚜虫的防治。在新梢抽发期若遇雨季,尤其是气温处于 20~28 °C 时,应注意加强柑橘褐斑病的防治。

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