

# 抗枯萎病粉蕉新品种育粉6号的选育

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**摘要:** 育粉6号是金粉1号粉蕉品种经组培诱变选育出来的抗香蕉枯萎病粉蕉新品种。新植蕉平均株高为335.3 cm, 假茎基围、中围为84.2和57.5 cm, 分别比金粉1号小27.1%、23.3%和11.5%。成熟果实可溶性固形物含量(w, 后同)为28.9%、可滴定酸含量为1.4%、维生素C含量为12.8 mg·100 g<sup>-1</sup>、还原糖含量为14.4%, 可食率为75.5%, 风味甘甜无酸, 品质优。新植蕉生长周期13~15个月, 比金粉1号短2~3个月, 宿根蕉生长周期比金粉1号短1~2个月。该品种高抗Foc 4号生理小种(*Fusarium oxysporum* f. sp. *cubense* race 4), 田间枯萎病发病率0.1%~5.0%。果实成熟后期无梅花点, 货架期4~6 d。该品种在我国香蕉产区种植均表现出较好的适应性。平均单株产量22.5 kg, 单位面积产量42 000 kg·hm<sup>-2</sup>(1860株·hm<sup>-2</sup>)。

**关键词:** 粉蕉; 新品种; 育粉6号; 抗病

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## Breeding of a new Pisang Awak (ABB) variety Yufen No. 6 with high resistance against *Fusarium oxysporum* f. sp. *cubense*

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**Abstract:** Yufen No. 6 is a new banana variety with high resistance against *Fusarium oxysporum* f. sp. *cubense*. The seedling was a mutant induced by tissue culture and selected through multiple generations, which had been bred through multiple generations. Due to its resistance to Fusarium wilt of banana, short growth cycle, dwarfing, and excellent comprehensive traits, it was selected in the primary election in 2014. From 2016 to 2018, a variety comparison test was carried out in Nanning, Yulin, Laibin, Congzuo of Guangxi Zhuang Autonomous Region and other sites. From 2018 to 2020, multiple regional tests and production tests were conducted in autonomous regions or provinces of Guangxi, Hainan, Guizhou, Yunnan, and Guangdong. The new cultivar was licensed by the State Forestry and Grassland Administration in March 2023. From the overall field evaluation results, this cultivar is a medium high pole type, and the average height of the newly planted banana pseudostem is 335.3 cm, with a base circumference and middle circumference being 84.2 and 57.5 cm, respectively. The false stem is yellow green in color and shiny, with a reddish-brown-black color. The leaves of the plant are significantly smaller than the control, with a length and width of 209.0 and 64.6 cm, which are 4.4% and 9.4% smaller than Jinfen No. 1, respectively. Both sides of leaf blade base are rounded. The color of the leaf surface, back and midrib is green and glossy, with a lot of wax powder on the back and sheath. The length of the petiole is 54.7 cm, which is 9.4% shorter than that of Jinfen No. 1. The shape is winged, and the edges of the petiole grooves are closed and overlapped. The fruit panicles are oblique-growing and short cylindrical, compact in structure, neat in comb and good in commodity characteristics. The fruit

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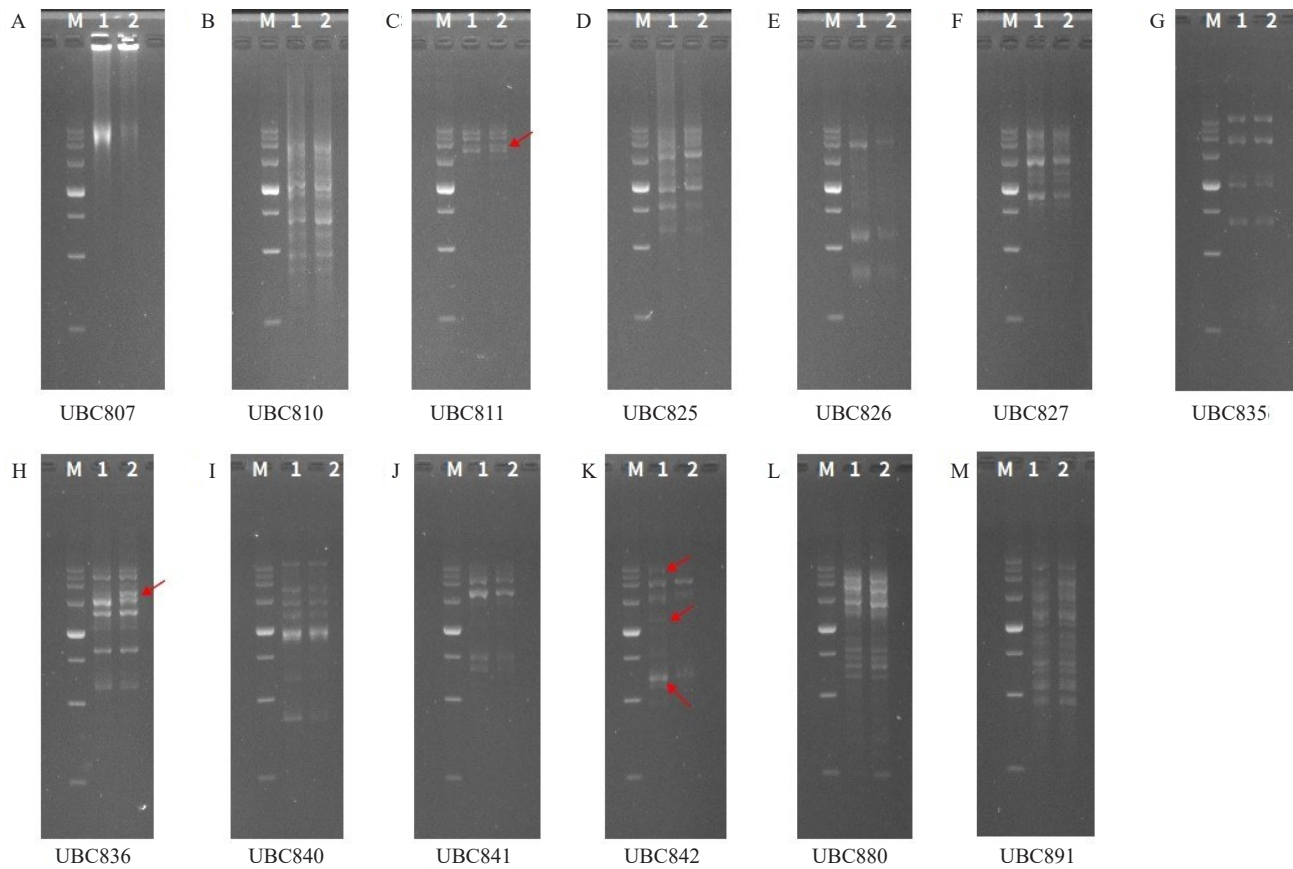
fingers are arranged in double rows, with a straight shape and indistinct fruit edges. The apex of the fruit fingers is blunt and pointed, and there are persistent floral organs. There is no hair on fruit stalk. The fruit skin is medium-green, the flesh is medium hardness, and the flesh is milky white. Ripe fruit skin is yellow, the flesh is milky white, and mature fruits are persistent, which don't fall from hands. The banana has sweet flavor without sour taste. The fruit edible rate is 75.5%. The soluble solids content of fruit is 28.9%, titratable acid content is 1.4%, reducing sugar content is 14.4%, and vitamin C content is  $12.8 \text{ mg} \cdot 100 \text{ g}^{-1}$ . At the late stage of maturity, there is no anthracnose spot on the surface of fruit peel. Fruit quality is excellent. The total number of sprouted leaves is 38–43, which is about 6–10, less than the control variety. The growth cycle of perennial banana seedlings is 11–13 months, which is 1–2 months shorter than that of Jinfen No. 1. The average yield per plant is 22.5 kg, and the production capacity is approximately 42 000 kg per  $\text{hm}^2$  (1860 plants per  $\text{hm}^2$ ). It is highly resistant to *Fusarium oxysporum* f. sp. *cubense* race 4, and the incidence rate is only 0.1%–5.0% in a severely infected field. There are no plum blossom spots in the late stage of fruit maturity, and the shelf life is about 4–6 days. This variety has a wide adaptability and has shown good adaptability when planted in tropical and subtropical banana producing areas such as Guangxi, Hainan, Guizhou, Yunnan, Guangdong, etc. The cultivation techniques of Yufen No. 6 are summarized from the following aspects of planting materials, plantation location, fertilization, watering management, pest control and field management.

**Key words:** Pisang Awak (ABB); New variety; Yufen No. 6; Disease resistance

香大蕉(*Musa* spp.)是世界重要的粮食作物和经济作物,为全球近6亿人口的主食,是世界鲜果贸易量最大的水果<sup>[1]</sup>。据FAO统计,2020年全世界香蕉总产量1.20亿吨,总产值4 129.25亿美元,其中我国香蕉总产量1 187.26万吨,总产值834.02亿美元,均居世界第二<sup>[2]</sup>。我国种植和消费的栽培蕉类型以三倍体香牙蕉(*Musa* AAA Cavendish)类品种为主,栽培蕉中另一重要的组成部分是粉蕉(*Musa* ABB Pisang Awak),果实香甜、软糯,销售价格高,经济效益稳定,对香蕉产业品种结构及产期调整起到积极作用<sup>[3–4]</sup>。然而,随着产业集约化程度加深,病虫害问题日益严重,其中香蕉枯萎病是一种毁灭性极强的真菌性病害,主要由尖孢镰刀菌古巴专化型(*Fusarium oxysporum* f. sp. *cubense*, *Foc*)侵染引起<sup>[5–6]</sup>;粉蕉栽培品种少,主栽品种(金粉1号、广粉1号等)普遍存在易感枯萎病、植株高大(460~500 cm)、生长周期过长(16~20个月)等问题,导致化肥、农药施用量大,自然灾害风险高,极大地限制了产业的绿色健康发展<sup>[7]</sup>。因此,选育并推广抗病、早熟、矮化等性状集于一体的粉蕉新品种是控制香蕉枯萎病蔓延、降低生产成本最有效的根本途径,对丰富我国香蕉产业品种结构以及产业健康可持续发展意义重大。

## 1 选育经过

2012年在金粉1号粉蕉离体快速繁殖过程中诱发体细胞无性系变异,获得变异后代,通过香蕉枯萎病区田间种植、观察,2014年从宿根蕉中筛选出4个抗枯萎病同时具有优良经济性状的粉蕉新单株,其中1个新单株同时还兼具植株相对矮化和早熟的优势特性,采集该优良单株(编号为55b)健壮吸芽,通过组织培养快繁获得2000株种苗,2015年3月移栽到田间,以易感病品种金粉1号为对照,果实采收后,采集具典型特征优良单株的健壮吸芽培养,并移栽田间种植,通过4次重复分离筛选及观察评价,获得综合性状优良、特异性明显且遗传稳定的55b优系。利用ISSR分子标记对55b及金粉1号的基因组DNA进行遗传分析,55b与金粉1号的多态性比率为7.7%,遗传相似系数为0.96,二者存在明显差异(图1)。于2016—2018年在广西南宁市、玉林市、来宾市、北海市、崇左市等地对该品种的植物学特征、主要经济学特性、生物学特性及抗性表现进行综合评价,确定其具有生产利用价值;2018—2020年在广西、海南、贵州、云南、广东等主产区开展生产试验,并对该品种在不同区域、不同季节的种植表现及配套栽培技术进行总结,为品种进一步推广与区域



M. 250 bp DNA Ladder; 1. 金粉 1 号; 2. 55b. UBC807 至 UBC891 为 ISSR 分子标记检测所用的引物。  
M. 250 bp DNA Ladder; 1. Jinfen No.1; 2. 55b. UBC807 to UBC891 are primers used for ISSR molecular marker detection.

图 1 PCR 扩增结果

Fig. 1 PCR amplification results

布局提供参考。经综合评价,该品种具有抗香蕉枯萎病、生长期短、植株明显矮化、优质丰产、风味香甜、遗传性状稳定的优点,定名为育粉6号。2020年7月17日申请中华人民共和国农业农村部植物新品种保护,经相关部门审核,2023年3月7日获得植物新品种权(品种权号为CNA20201004033)。

## 2 主要性状

### 2.1 植物学特征

育粉6号表现为植株树势中庸,主要植物学性

状测试结果如表1所示,新植蕉假茎平均高度335.3 cm,假茎基围84.2 cm、中围57.5 cm,与金粉1号相比分别小27.1%、23.3%和11.5%,假茎颜色黄绿色,有光泽;育粉6号冠幅较金粉1号明显小,叶姿下垂,叶片长度209.0 cm、宽度64.6 cm,叶柄长度54.7 cm,与金粉1号相比明显小4.4%、9.4%和9.4%,叶片长宽比为3.2,叶片基部形状为两边圆形且对称;叶面、叶背和叶片中脉颜色均为绿色,有光泽,叶背和叶鞘蜡粉多;叶柄形状为翼状且不紧抱假茎,叶柄槽边缘闭合交叠;花穗轴向下斜生,收获时雄花蕾形状近椭圆

表 1 果实主要植物学性状比较

Table 1 Comparison of main botanical characters of fruits

品种 Cultivar	假茎高度 Pseudostem height/cm	假茎基围 Pseudostem base girth/cm	假茎中围 Pseudostem middle girth/cm	叶片长度 Leaf length/cm	叶片宽度 Leaf width/cm	叶柄长度 Petiole length/cm
育粉6号 Yufen No.6	335.3±15.5 b	84.2±5.5 b	57.5±7.5 a	209.0±8.5 a	64.6±5.5 b	54.7±4.0 a
金粉1号 Jinfen No.1	459.7±20.0 a	109.8±6.5 a	65.0±5.0 a	218.6±7.6 a	71.3±5.5 a	60.4±5.0 a

注:表中数据为平均值±标准误,经 Duncan 方差分析,同列数据不同小写字母表示差异达显著水平( $p < 0.05$ )。下同。

Note: The data in the table are average value ± standard error. According to Duncan variance analysis, the data in the same column with different small letters show a significant difference ( $p < 0.05$ ). The same below.

圆形,花蕾顶部苞片排列小覆瓦状,外表面颜色为紫粉红色,蜡粉较多,内表面颜色为红色,苞片顶部形状钝尖,苞片无宿存性,花序轴疤痕突出程度大(图2)。

## 2.2 果实经济性状

育粉6号果穗呈圆柱形,结构紧密,果穗长度82.9 cm,宽度40.2 cm,与金粉1号相比分别小4.4%

和6.5%,穗柄颜色为绿色,周长20.7 cm,果梳数中多,平均12.3梳,梳形整齐,果指双排排列,果指形状直,果棱不明显,果顶钝尖且有花器官宿存。果指平均长度为15.0 cm,周长为13.6 cm,与金粉1号相比分别小5.1%和4.2%,果柄无毛;生果皮绿色,果肉硬度中等,果肉为乳白色;平均单株产量为22.5 kg,单



图2 粉蕉新品种育粉6号

Fig. 2 A new banana cultivar Yufen No.6

位面积产量约42 000 kg·hm<sup>-2</sup>(1860株·hm<sup>-2</sup>);一年四季可结果,以3—6月上市收获为正造果,果实产量高、品质好、售价高。

育粉6号熟果皮颜色为黄色,果实不易脱把,无裂果情况,果皮薄,厚度为2.8 mm,易剥离,熟果肉颜色为乳白色,果肉质地软滑、细腻,可食率75.5%,风味甘甜、无酸,品质优,可溶性固形物含量为28.9%,可滴定酸含量为1.4%,维生素C含量为12.8 mg·100 g<sup>-1</sup>,还原糖含量为14.4%,主要品质性状测试结果如表2所示,与金粉1号相比整体风味基本一致,无显著差异。果实成熟后期无梅花点,货架期约4~6 d。

## 2.3 生物学特性

在广西南宁地区,3月上旬(春植)定植6~8叶龄

营养杯苗,9月中下旬—10月中下旬抽蕾,次年4月中旬开始陆续收获,收获时存绿叶数8~11片,育粉6号植株生长总叶片数为38-43片,与金粉1号相比叶片数少6~10片,与其生长周期短吻合;育粉6号新植蕉生长周期一般13~15个月,与金粉1号相比短2~3个月,留芽宿根蕉生长周期为11~13个月,与金粉1号相比短1~2个月,冬季气温低或肥水不足时生长周期稍长。

## 2.4 抗性和适应性

2015—2019年在广西南宁市武鸣区、西乡塘区,玉林市福绵区、玉州区,崇左市龙州县,来宾市武宣县,贵州省望谟县等地的香蕉种植区试验种植,累计3万余株,田间调查枯萎病发病植株,与金粉1号

表2 果实主要品质性状比较

Table 2 Comparison of main quality characters of fruits

品种 Cultivar	w(可溶性固形物) Soluble solids content/%	w(可滴定酸) Titratable acid content/%	w(维生素C) Vitamin C content/ (mg·100 g <sup>-1</sup> )	w(还原糖) Reducing sugar content/%	w(蔗糖) Sucrose content/%	w(可溶性糖) Soluble sugar content/%	可食率 Edible rate/%
育粉6号 Yufen No.6	28.9±1.4 a	1.4±0.5 a	12.8±0.5 a	14.4±1.1 a	8.5±0.7 a	24.9±1.2 a	75.5±2.0 a
金粉1号 Jinfen No.1	28.6±1.5 a	1.7±0.4 a	11.3±0.7 a	14.2±1.0 a	9.1±0.6 a	23.5±1.0 a	77.2±2.2 a

相比育粉6号枯萎病发病率明显低,在感染*Foc4*生理小种的种植园中,金粉1号的发病率为10.0%~30.0%,育粉6号的发病率为0.1%~5.0%;在感染*Foc1*生理小种的种植园中,金粉1号的发病率为30.0%~100.0%,育粉6号的发病率为1.0%~10.0%;育粉6号宿根留芽也表现出较强的抗病性,宿根蕉发病率低于组培新植蕉,可宿根栽培。抗病性苗期鉴定结果表明,接菌( $1 \times 10^5$ 个孢子 $\cdot$ mL<sup>-1</sup> *Foc1*)后20 d金粉1号开始出现轻微的病症,此时,育粉6号没有病症;接菌后80 d,金粉1号发病率95.6%,死亡率75.0%,育粉6号仅有极少数出现轻微黄化现象,发病率为6.5%。相较于香芽蕉,育粉6号对土壤和气候的适应性较强;与金粉1号相比,育粉6号植株矮小、株型紧凑、叶片短窄、抗风性较强;育粉6号开花期和收获期比金粉1号提前,降低自然灾害风险、节约种植管理成本。该品种适应范围广,在广西、海南、贵州、云南、广东等热带及南亚热带香蕉产区种植均表现出较强的适应性,截至目前育粉6号在广西的推广面积已超过800 hm<sup>2</sup>,并在各种植区均有逐年增加的趋势。

### 3 栽培技术要点

#### 3.1 种苗选择与定植

选择种源纯正、无病虫害、根系发达、达到8片叶的健壮组培苗定植。根据不同的种植条件和管理水平确定种植密度为1800~2400株 $\cdot$ hm<sup>-2</sup>。春植宜在3—4月进行,秋植宜在9—11月进行。

#### 3.2 水肥管理

施肥以有机肥为主,化学肥料为辅。贫瘠土壤应施足基肥,追肥按照“前促、中控、后补”的原则,肥料可随灌溉系统一起喷淋,也可撒施在畦面后喷水淋溶,采收前20~30 d停止施肥。

#### 3.3 树体管理

及时割除黄化或干枯叶片。选留母株出蕾方向背面或侧面的健壮吸芽,其他吸芽及时平地面割除并捣碎生长点。果穗宜留7~8梳蕉果。当梳数足够时,割除多余部分蕉果和花蕾,在末梳留2~3个节位的穗柄。

#### 3.4 病虫害防治

贯彻“预防为主,综合防治”的植保方针,以改善

蕉园生态环境,加强栽培管理为基础,综合应用各种防治措施,优先采用农业防治、生物防治和物理防治措施,科学合理的化学防治。严格执行国家规定农药使用准则及安全间隔期,重点预防细菌性软腐病、鞘腐病、煤烟病等主要病害和象甲、交脉蚜等主要虫害。采用草铵膦类除草剂结合人工的方式除草。

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