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荔枝DUS测试数量性状分级研究

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摘 要：【目的】荔枝特异性、一致性和稳定性（DUS）测试指南中的数量性状是极易受环境条件影响的性状。通过对荔枝测试指南中数量性状的分级研究，以期为荔枝品种数量性状客观准确的描述提供技术依据，以确保荔枝品种DUS测试工作顺利开展。【方法】以74个具有广泛代表性的荔枝品种为研究对象，对荔枝测试指南中9个数量性状进行观测，并依据各性状的特点选择最适的分级方法，对各数量性状的表达状态进行分级范围划分。【结果】9个数量性状变异范围为12.35%~33.09%，性状间相关系数分布在-0.14~0.75之间；正态性分析（K-S检验）结果表明，9个数量性状中有7个数量性状符合正态分布，采用最小显著差法分级，其他性状用极差法分级。【结论】对9个数量性状进行的分级范围研究结果可作为今后荔枝DUS测试数量性状描述分级的依据。

关键词：荔枝；DUS测试；数量性状；相关性

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A study on grading of quantitative characteristics of litchi

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Abstract: 【Objective】The DUS test guideline is an important technical standard for DUS testing, in which the characteristics are divided into qualitative characteristics, quantitative characteristics and pseudo-qualitative characteristics according to their expression states. However, the nine quantitative characteristics in litchi (*Litchi chinensis* Sonn.) DUS test guideline about the autumn shoot, the flowers and the fruit edible rate only have grades and standard varieties, and there is no grade range for each grade, resulting in some difficulties to the accurate description of quantitative characteristics during litchi DUS testing. Therefore, the grade range and correlation of the nine quantitative characteristics were studied in order to provide technical basis for the accurate and objective description and observation of litchi quantitative characteristics, and for the correct determination of distinctness, uniformity and stability of litchi variety under testing.【Methods】Following the litchi DUS test guideline, nine quantitative characteristics were observed of the 74 litchi varieties in the Litchi Germplasm Resource Collection, College of Horticulture, South China Agricultural University. Samples were collected from the upper and middle periphery of the tree crown. 10 freshly green leaves and 10 annual branches were collected during the autumn shoot period to measure leaf length, leaf width, petiole length, branch thickness, internode length and leaf axis length. 10 flower spikes were collected in flowering stage to measure flower spike length and width. 10 mature fruits were collected in fruit ripening stage to measure the edible rate. The SPSS statistic software was used to test the normality of the data, and the R language was used for correlation analysis and mapping. For the quantitative characteristics conformed to be the normal distribution, the least signifi-

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cant difference method was used for grading. The average value of the measured data was taken as the center and the two sides were divided equally with the grade difference which was greater than or equal to 2 times LSD 0.05. For quantitative characteristics out of the normal distribution, the grade difference method was used for grading. Firstly, the grade difference of each quantitative characteristic was calculated by the ratio of the range and the grade number. Then the median of distribution range was used as the grade midpoint, and the range was divided according to the formula y= G±(1/2+n)x, (n = 0, 1, 2, 3, 4, G as the data median, x as the grade difference).【Results】The median and mean values of the 9 quantitative characteristics data were basically equal, indicating that the distribution of each characteristic of these 74 varieties were relatively regular without obvious extreme value, and the variation of the characteristics was mainly the result of natural selection. Among the 9 quantitative characteristics, the smallest coefficient of variation was the branch thickness, which was 12.35%, indicating that the expression status of the characteristic was similar. The largest coefficient of variation was the flower spike width, which was 33.09%, indicating that the genetic variation of this characteristic was rich. The variation range of the fruit edible rate was between 23.85% and 90.43%., which indicated that the tested varieties were representative. The results of K-S normality test showed that the bilateral significance (Sig.) of the leaf axis length, the branch thickness and the fruit edible rate was over 0.05, which was in line with normal distribution. The Sig. of the internode the length, the leaf length, the spike length and the spike width was less than 0.05, but because the absolute values of the skewness and the kurtosis were less than 1, and they could be treated as normal distribution. The Sig. of the leaf width and the petiole length was less than 0.05, as the absolute value of their kurtosis was over 1, and they were not conformed to be the normal distribution. Thus, in accordance with the normal distribution, the variance analysis of the leaf axis length, the branch thickness, the fruit edible rate, the internode length, the leaf length, the flower spike length and width was conducted, and the values of $LSD_{0.05}$ were 0.53, 0.17, 0.056, 0.31, 081, 2.6, and 2.93 respectively. According to the above method, the seven quantitative characteristics were divided into 9 grades, 3 grades, 7grades, 7 grades, 9 grades, 7 grades, and 3 grades respectively. The leaf width and the petiole length that did not meet the normal distribution were divided into 9 and 3 grades using the range method. The correlation analysis of the 9 quantitative characteristics showed that there was a significant positive correlation between the spikelet length and the five characteristics including the internode length, the leaf axis length, the spikelet width, the leaf width and the leaf length, among them the correlation coefficient with the spikelet width was the highest (0.75). There was a significant positive correlation between the internode length and the four characteristics including the branch thickness, the flower spike width, the fruit edible rate and the petiole length. There was a significant correlation between the length of leaf axis and the four characteristics including the branch thickness, the flower spike width, the leaf width and the petiole length. The correlation coefficient between the branch thickness and the fruit edible rate was -0.14. The correlation between the leaf width and the petiole length was very significant.【Conclusion】The results of the correlation analysis of 9 quantitative characteristics showed a very high correlation coefficient between the spikelet length and the spikelet width. Therefor, these two characteristics might be considered to merge into one characteristic in the test process to reduce the work of the DUS testing. As the quantitative characteristics are usually affected by the changes of environmental conditions and the data was only collected in Guangzhou, the classification results might not be completely suitable for the other ecological regions. Therefore, the classification scope needs to adjust according to the performance of standard varieties in different ecological regions.

Key words: Litchi; DUS; Quantitative characteristics; Correlation

荔枝为无患子科（Sapindaceae）、荔枝属（*Litchi chinensis* Sonn.）常绿果树，起源于中国，早在西汉年间就有种植，距今已有2 000多年的栽培历史[1-2]。我国是世界上荔枝种质资源最丰富的国家，据不完全统计，我国荔枝种质资源已超过500份，主要分布在广东、广西、海南、福建、台湾等地区，贵州、四川、云南等地区也有种植[3-4]。荔枝作为我国南方重要的果树，每年的栽培面积不断上涨，截至2018年，我国荔枝栽培面积达到57.3万hm^2，年产量200多万t，居世界首位[5]。为鼓励荔枝育种创新，加强国际间交流合作，早在2002年荔枝就被列入我国第四批植物新品种保护名录，开始对荔枝品种进行品种权保护。截至2019年，荔枝品种权申请量为6个，授权品种有2个[6]。

《植物品种特异性、一致性和稳定性测试指南》（简称DUS测试指南）是植物品种DUS测试、品种权授权和维护的重要技术标准。华南农业大学陈厚彬教授主持研制的荔枝DUS测试指南于2014年以农业行业标准正式发布，同年该指南被国际植物新品种保护联盟（UPOV）采纳为国际标准。DUS测试指南中的性状分为质量性状、数量性状和假质量性状三种类型，其中数量性状因其表达状态极易受环境影响的特点难以被准确描述，为了解决这一困难，前人已对核桃[7]、杏[8]、猕猴桃[9]等多种果树的数量性状分级进行了相关研究。在荔枝DUS测试指南中，关于秋梢期、花期和果实成熟期观测的9个数量性状只有分级数和标准品种，没有给出每一级的分级范围，为荔枝DUS测试数量性状的客观描述带来诸多不便。为更好地发挥荔枝DUS测试指南的指导作用，方便荔枝品种DUS测试工作的开展，笔者对74个荔枝品种不同时期的数量性状进行了观测，对枝条粗度、节间长度、叶轴长度、叶片长度、叶片宽度、叶柄长度、花穗长度、花穗宽度和果实可食率等9个数量性状进行了分级研究和相关性分析，以期为荔枝品种DUS测试数量性状观测、描述以及DUS三性判定提供技术依据。

1　材料和方法

1.1　材料

74个荔枝已知品种由华南农业大学园艺学院荔枝课题组提供，品种信息如表1所示。参试品种主要为福建、广东和广西的主栽品种，对华南地区荔枝种质资源具有较好的代表性。

1.2　数据采集方法

依据中华人民共和国农业行业标准NY/T 2564—2014《植物新品种特异性、一致性和稳定性测试指南 荔枝》于2018—2019年进行田间性状数据采集：秋梢期，选取树冠外围中上部完全成熟的10个秋梢枝条测量枝条粗度、节间长度、叶轴长度，选取树冠外围中上部刚转绿的复叶中部两枚小叶片测量10个叶片长度、叶片宽度、叶柄长度；花期选取树冠外围中上部10个花穗测量花穗长度和花穗宽度；果实成熟期选取10个发育良好的果实测算可食率。

1.3　数据处理方法

所有数据采用Excel 2007计算最大值、最小值、中位数、平均值、标准差和变异系数，通过SPSS Statistics软件进行数据正态性检验，利用R语言进行相关性分析作图。

2　结果与分析

2.1　数量性状变异分析

由表2可以看出，9个数量性状数据的中位数与均值相近，表明这些材料的各性状分布比较规则，性状的变异主要是自然选择的结果；其中变异系数最小的是枝条粗度，为12.35%，说明该性状比较稳定；变异系数最大的是花穗宽度，为33.09%，说明该性状的遗传变异较为丰富；果实可食率变异范围在23.85%~90.43%之间，较大的变异幅度说明供试品种的成熟期变化范围广[10]，在该性状上具有较好的代表性。

2.2　荔枝数量性状正态性检验

在对荔枝种质资源DUS测试9个数量性状变异情况统计分析的基础上，绘制了数量性状分布频次图（图1）。经K-S正态性检验，结果表明：叶轴长度、枝条粗度和果实可食率的双侧显著性（Sig.）＞0.05，符合正态分布；节间长度、叶片长度、花穗长度和花穗宽度的Sig.＜0.05，但因其偏度和峰度的绝对值均小于1，可按近似于正态分布处理；叶片宽度、叶柄长度Sig.＜0.05，但因其峰度的绝对值均大于1，不符合正态分布（表3）。

2.3　正态分布和近似正态分布数量性状分级

对符合正态分布或近似正态分布的性状采用

表1 供试荔枝品种信息

Table 1 List of litchi varieties tested

编号 Number	品种名 Name	保存地 Place of preservation	编号 Number	品种名 Name	保存地 Place of preservation
1	雪怀子 Xuehuaizi	广州 Guangzhou	38	荷花大红荔 Hehuadahongli	广州 Guangzhou
2	沙坑种 Shakengzhong	广州 Guangzhou	39	怀枝 Huaizhi	广州 Guangzhou
3	楠西早生 Nanxizaosheng	广州 Guangzhou	40	金钟 Jinzhong	广州 Guangzhou
4	六月雪 Liuyuexue	广州 Guangzhou	41	三月红 Sanyuehong	广州 Guangzhou
5	粉红桂味 Fenhongguiwei	广州 Guangzhou	42	糯米糍 Nuomici	广州 Guangzhou
6	宋家香 Songjiaxiang	广州 Guangzhou	43	鸡嘴荔 Jizuili	广州 Guangzhou
7	年年红2号 Niannianhong2	广州 Guangzhou	44	陈紫 Chenzi	广州 Guangzhou
8	大造 Dazao	广州 Guangzhou	45	白荔 Baili	广州 Guangzhou
9	观音绿 Guanyinlv	广州 Guangzhou	46	硬枝早红 Yingzhizaohong	广州 Guangzhou
10	岭丰糯 Lingfengnuo	广州 Guangzhou	47	水林 Shuilin	广州 Guangzhou
11	保甸荔1号 Baodianli1	广州 Guangzhou	48	庙种糯 Miaozhongnuo	广州 Guangzhou
12	妃子笑 Feizixiao	广州 Guangzhou	49	十月荔 Shiyueli	广州 Guangzhou
13	禾虾串 Hexiachuan	广州 Guangzhou	50	水密 Shuimi	广州 Guangzhou
14	榆林丁香 Yulindingxiang	广州 Guangzhou	51	白糖罂 Baitangyin	广州 Guangzhou
15	Kom	广州 Guangzhou	52	大红袍 Dahongpao	广州 Guangzhou
16	青皮甜 Qingpitian	广州 Guangzhou	53	尖叶 Jianye	广州 Guangzhou
17	紫娘喜 Ziniangxi	广州 Guangzhou	54	软枝早红 Ruanzhizaohong	广州 Guangzhou
18	南非怀枝 Nanfeihuaizhi	广州 Guangzhou	55	猪母乳 Zhumuru	广州 Guangzhou
19	尚书怀 Shangshuhuai	广州 Guangzhou	56	霞浦荔 Xiapuli	广州 Guangzhou
20	灵山香荔 Linshanxiangli	广州 Guangzhou	57	大锦钟 Dajinzhong	广州 Guangzhou
21	卡乐卡 Kaleka	广州 Guangzhou	58	玉荷包 Yuhebao	广州 Guangzhou
22	黑叶 Heiye	广州 Guangzhou	59	下番枝 Xiafanzhi	广州 Guangzhou
23	白驳早红 Baibozaohong	广州 Guangzhou	60	蔡坑肉丸 Caikengrouwan	广州 Guangzhou
24	金银宝 Jinyinbao	广州 Guangzhou	61	香荔 Xiangli	广州 Guangzhou
25	小金钟 Xiaojinzhong	广州 Guangzhou	62	乌叶舅 Wuyejiu	广州 Guangzhou
26	状元红 Zhuangyuanhong	广州 Guangzhou	63	皇帝舅 Huangdijiu	广州 Guangzhou
27	泉州早红 Quanzhouzaohong	广州 Guangzhou	64	晚埔 Wanpu	广州 Guangzhou
28	贡仔 Gongzai	广州 Guangzhou	65	桶仔 Tongzai	广州 Guangzhou
29	Bengal	广州 Guangzhou	66	南海荔 Nanhaili	广州 Guangzhou
30	桂林 Guilin	广州 Guangzhou	67	东刘1号 Dongliu1	广州 Guangzhou
31	库林 Kulin	广州 Guangzhou	68	早红 Zaohong	广州 Guangzhou
32	及第 Jidi	广州 Guangzhou	69	早埔 Zaopu	广州 Guangzhou
33	犀角子 Xijiaozi	广州 Guangzhou	70	兰竹 Lanzhu	广州 Guangzhou
34	龙眼本 Longyanben	广州 Guangzhou	71	丛星 Congxing	广州 Guangzhou
35	四两果 Siliangguo	广州 Guangzhou	72	凤花 Fenghua	广州 Guangzhou
36	乌叶 Wuye	广州 Guangzhou	73	桂味 Guiwei	广州 Guangzhou
37	马贵荔 Maguili	广州 Guangzhou	74	井岗红糯 Jingganghongnuo	广州 Guangzhou

表2　荔枝DUS测试数量性状的变异分析

Table 2　Variation analysis of the quantitative characteristics in litchi DUS testing

性状 Trait	最小值 Min	最大值 Max	均值 Average	中位数 Median	标准差 SD	变异系数 Coefficient of variation/%
节间长度 Internode length/cm	1.20	5.30	2.76	2.70	0.72	26.09
枝条粗度 Thickness of branches/cm	1.85	4.50	3.02	3.00	0.37	12.35
叶轴长度 Leaf axis length/cm	2.40	9.10	5.80	5.80	1.17	20.17
叶片长度 Blade length/cm	7.00	16.00	11.31	11.15	1.68	14.85
叶片宽度 Blade width/cm	2.10	6.20	3.76	3.70	0.57	15.16
叶柄长度 Petiole length/cm	0.30	1.20	0.61	0.60	0.12	19.67
花穗长度 Flower spike length/cm	7.60	46.20	22.77	22.30	6.05	26.57
花穗宽度 Flower spike width/cm	5.80	40.00	19.25	18.60	6.37	33.09
可食率 Edible rate/%	23.85	90.43	63.16	64.32	11.00	17.89

最小显著差法分级[11]。首先计算每个数量性状的$LSD_{0.05}$的值，7个符合正态分布或近似正态分布的数量性状的$LSD_{0.05}$值如表4所示。

依据荔枝测试指南中数量性状的表达状态，叶轴长度与叶片长度分为9级，以第5级为中心划分分级范围；枝条节间长度、花穗长度和果实可食率分为7级，以第4级为中心划分分级范围；枝条粗度和花穗宽度分为3级，以第2级为中心划分分级范围。7个数量性状以测量数据的平均值为中心，级差大于等于2倍$LSD_{0.05}$向两侧进行等距划分，再通过实际情况对每个区间进行调整，最终分级结果如表5所示。

2.4　非正态分布数量性状分级

对不符合正态分布的数量性状，使用极差法进行分级[12]。首先通过极差与分级数的比值计算出每一个数量性状的级差，叶柄长度和宽度的级差分别为0.5和0.3（表6）。然后以分布范围的中位数为分级中点，按公式y=G±（1/2+n）x（n=0、1、2、3、4，G为数据中位数，x为级差）进行级别划分，得出叶柄长度和宽度两个数量性状的分级范围（表7）。

2.5　荔枝DUS测试数量性状相关性分析

为了解各数量性状间的相互关系，对荔枝DUS测试的叶片长度、叶片宽度、叶柄长度、叶轴长度、枝条粗度、节间长度、花穗长度、花穗宽度及可食率9个数量性状进行相关性分析（图2），结果显示：花穗长度与节间长度、叶轴长度、花穗宽度、叶片宽度、叶片长度5个数量性状呈极显著正相关，其中与花穗宽度相关系数最大（0.75）；节间长度与枝条粗度、花穗宽度、可食率、叶柄长度4个性状呈极显著正相关，与叶轴长度不相关；叶轴长度与枝条粗度、花穗宽度、叶片宽度、叶柄长度4个性状呈极显著相关；枝条粗度与可食率呈显著负相关，相关系数为−0.14；叶片宽度与叶柄长度呈极显著相关。

3　讨　论

本研究的参试品种大部分为我国南方主栽品种，品种代表性强，品种间差异显著，而且还包括了不少测试指南中一些标准品种，如‘白糖罂’‘桂味’‘妃子笑’和‘三月红’等。因此，所选用的参试品种比较合适作为数量性状分级研究的对象。数量性状分级的方法有多种，王永行等[13]利用1/7等距法将符合正态分布的向日葵花盘直径等四个数量性状按照测试指南划分为9级；同样该方法在猕猴桃[9]、杧果[14]DUS测试的数量性状分级中也得到运用。这种传统的等距法分级虽然计算简便，但因为人为误差和客观存在的认知障碍，分级点的选取可能存在误差，并不是很可靠的分级方法。刘孟军[15]首次使用概率分级法对枣树的数量性状进行分级，

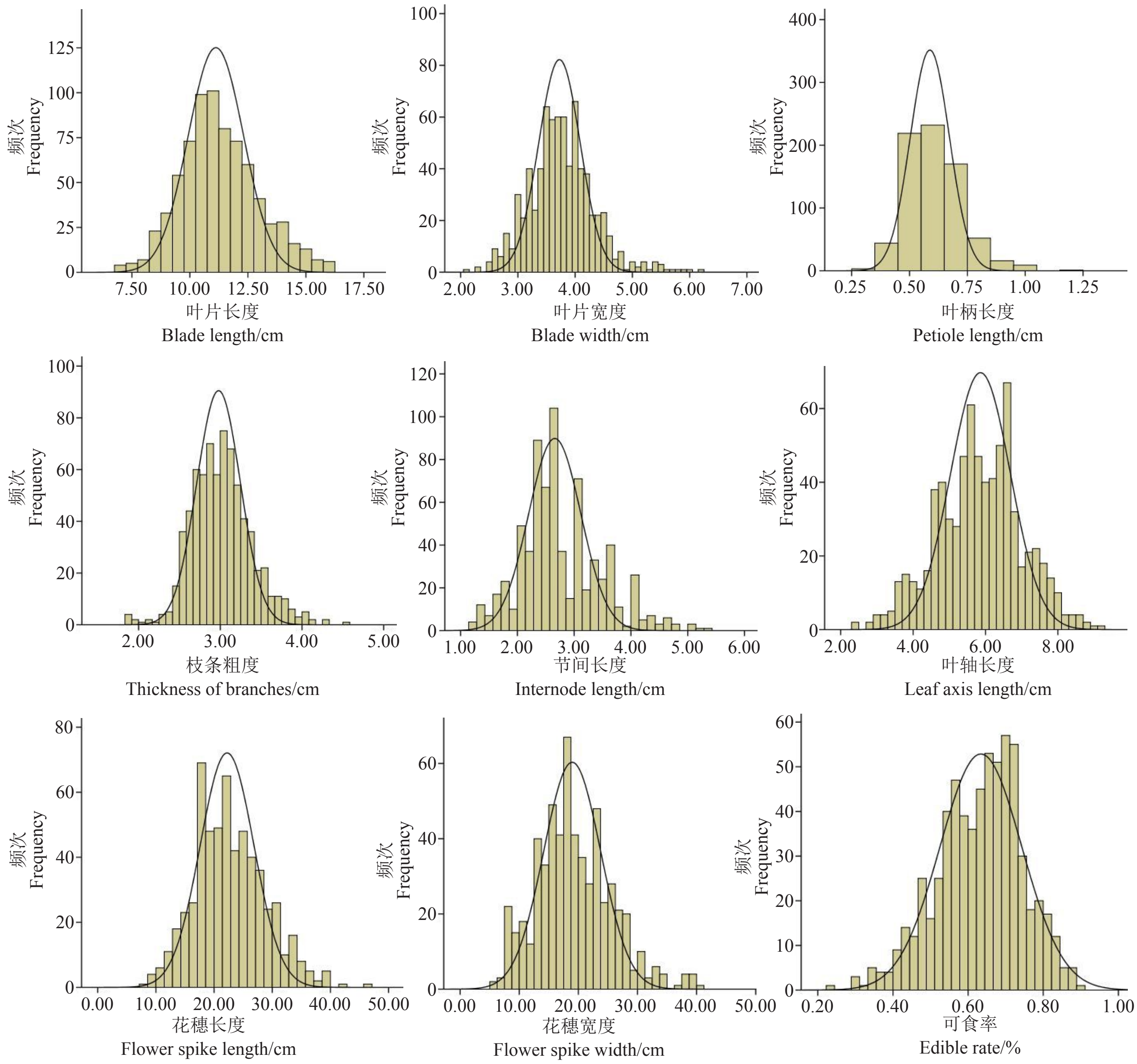


图1 9个数量性状频次分布图

Fig. 1 Frequency distribution of 9 quantitative characteristics

表3 荔枝DUS测试数量性状K-S检验

Table 3 K-S normal test of the quantitative characteristics in litchi DUS testing

性状 Characteristic	样本量 Sample size	极差 Range			K-S值 K-S value	Sig. 值 Sig. value	偏度 Skewness	峰度 Kurtosis
		绝对值 Absolute value	正 Positive	负 Negative				
节间长度 Internode length	726	0.111	0.111	-0.048	2.996	0.000	0.592	0.432
枝条粗度 Thickness of branches	728	0.050	0.050	-0.036	1.353	0.051	0.370	0.845
叶轴长度 Leaf axis length	724	0.049	0.040	-0.049	1.310	0.065	-0.086	-0.124
叶片长度 Blade length	750	0.059	0.059	-0.035	1.604	0.012	0.358	0.004
叶片宽度 Blade width	748	0.074	0.074	-0.056	2.018	0.010	0.544	1.344
叶柄长度 Petiole length	746	0.188	0.188	-0.130	5.148	0.000	0.687	1.049
花穗长度 Flower spike length	584	0.059	0.059	-0.028	1.430	0.033	0.415	0.157
花穗宽度 Flower spike width	584	0.057	0.057	-0.026	1.371	0.047	0.512	0.390
可食率 Edible rate	650	0.048	0.027	-0.048	1.230	0.097	-0.355	-0.040

表4　荔枝DUS测试数量性状方差分析

Table 4　Analysis of variance of quantitative characteristics in litchi DUS testing

性状 Characteristics	变异来源 Source of variation	平方和 Sum of square	*df*	均方 Mean square	*F*	显著性 Significance	$LSD_{0.05}$
叶轴长度 Leaf axis length/cm	组间 Between groups	756.850	72	10.512	28.970	0	0.53
	组内 Within the group	236.216	651	0.363			
	总数 Total	993.066	723				
叶片长度 Blade length/cm	组间 Between groups	1 526.674	74	20.631	24.236	0	0.81
	组内 Within the group	574.595	675	0.854			
	总数 Total	2 101.269	749				
枝条粗度 Thickness of branches	组间 Between groups	77.361	72	1.074	29.480	0	0.17
	组内 Within the group	23.873	655	0.036			
	总数 Total	101.234	727				
节间长度 Internode length	组间 Between groups	292.558	72	4.063	31.833	0	0.31
	组内 Within the group	83.479	654	0.128			
	总数 Total	376.037	726				
花穗长度 Flower spike length	组间 Between groups	16 602.814	59	281.404	31.115	0	2.6
	组内 Within the group	5 792.041	524	11.054			
	总数 Total	21 341.825	583				
花穗宽度 Flower spike width	组间 Between groups	17 873.589	59	302.942	27.407	0	2.93
	组内 Within the group	5 792.041	524	11.054			
	总数 Total	23 665.620	583				
可食率 Edible rate	组间 Between groups	5.902	64	0.092	22.523	0	0.06
	组内 Within the group	2.395	585	0.004			
	总数 Total	8.297	649				

表5　荔枝DUS测试数量性状分级范围

Table 5　Grading range of quantitative characteristics in litchi DUS testing

分级 Grading range	叶轴长度 Leaf axis length/cm	叶片长度 Blade length/cm	枝条粗度 Thickness of branches/cm	节间长度 Internode length/cm	花穗长度 Flower spike length/cm	花穗宽度 Flower spike width/cm	果实可食率 Edible rate/%
1	≤1.5	≤3.3	≤2.8	≤0.7	≤9.2	≤16.3	≤34.4
2	1.6~2.7	5.0~6.7	2.9~3.2	0.8~1.5	9.3~14.6	16.4~22.3	34.5~45.9
3	2.8~3.9	6.8~8.5	≥ 3.3	1.6~2.3	14.7~20.0	≥ 22.4	46.0~57.4
4	4.0~5.1	8.6~10.3		2.4~3.2	20.1~25.4		57.5~68.9
5	5.2~6.4	10.4~12.2		3.3~4.0	25.5~30.8		69.0~80.4
6	6.5~7.6	12.3~14.0		4.1~4.8	30.9~36.2		80.5~91.9
7	7.7~8.8	14.1~15.8		≥ 4.9	≥ 36.3		≥ 92.0
8	8.9~10.0	15.9~17.6					
9	≥ 10.1	≥ 17.7					

表6 非正态分布数量性状极差表

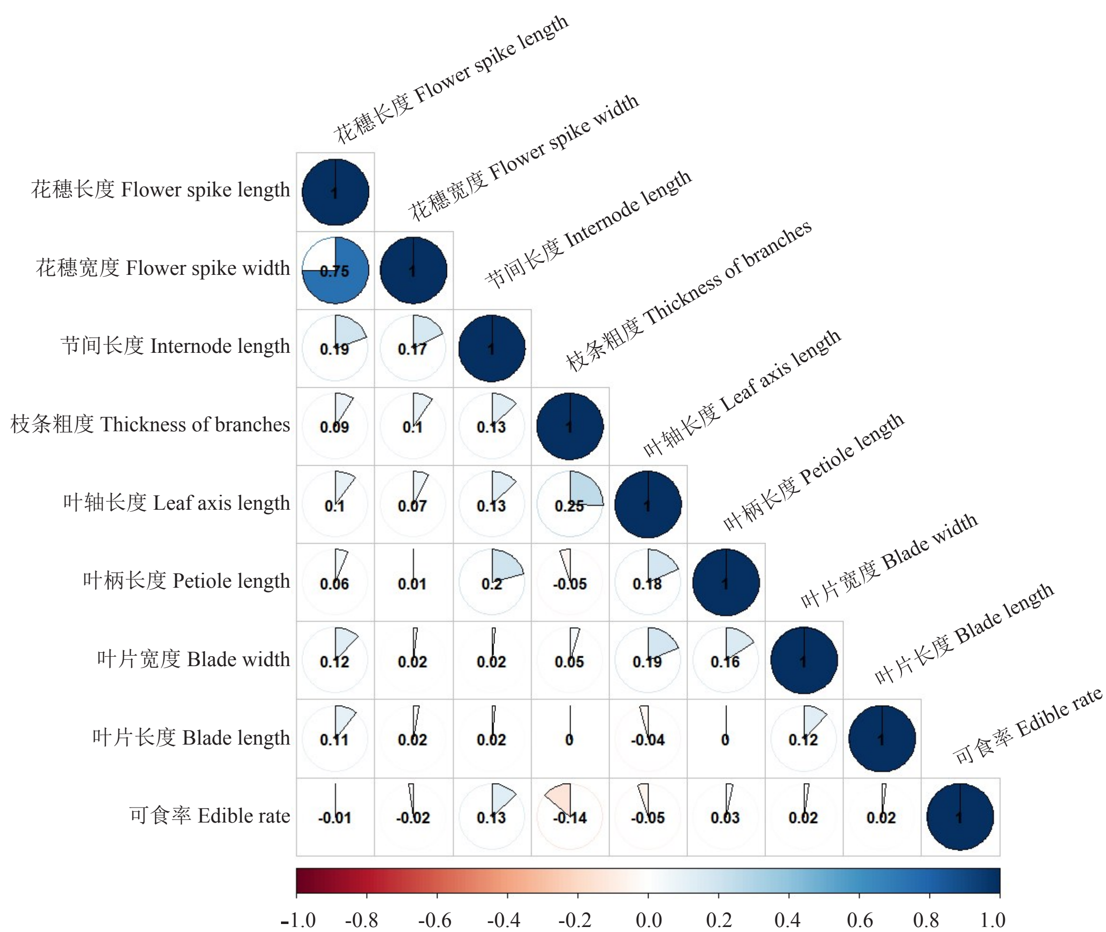
Table 6 Non-normal distribution quantitative characteristics

性状 Characteristics	中位数 Median	极差 Range	分级数 Number of ratings	级差 Step
叶片宽度 Blade width/cm	3.7	4.1	9	0.5
叶柄长度 Petiole length/cm	0.6	0.9	3	0.3

表7 非正态分布数量性状分级标准

Table 7 Non-normal distribution quantitative characteristics grading standards

性状 Characteristics	分级 Grading range								
	1	2	3	4	5	6	7	8	9
叶片宽度 Blade width/cm	≤1.6	1.7~2.2	2.3~2.8	2.9~3.4	3.5~4.0	4.1~4.6	4.7~5.2	5.3~5.8	≥5.9
叶柄长度 Petiole length/cm	≤0.4	0.5~0.9	≥1.0						



扇形面积大小表示相关系数大小，颜色深浅表示相关性水平。

The size of the fan area indicates the correlation coefficient, and the color depth indicates the correlation level.

图2 数量性状相关性热图

Fig. 2 Correlation heat map of quantitative characteristics

随后该方法在杏[16]、菊[17]、杜仲[18]、平榛[19]等植物的数量分级中也得到成功应用。概率分级法虽然符合数据分布规律，具有较高的科学性，但是该分级方法也存在比较明显的缺陷：概率分级法只能将数量性状分为3级或5级，对于测试指南中分级为7级和9级的偶数级（2级、4级、6级、8级）无法确定分级范围。

本研究根据不同数据分布的特点，对符合正态

分布和不符合正态分布的数量性状分别采用最小显著差法和级差法进行分级,最后确定了每个数量性状不同表达状态的分级范围,分级结果可以作为今后荔枝 DUS 测试过程中数量性状代码赋予的参考,填补了荔枝数量性状分级研究的空白。由于本次分级范围划分的研究是在广州完成的,鉴于数量性状受环境条件变化影响较大,研究结果可能并不完全适合其他生态区,因此,需要根据标准品种在不同生态区的表现对该分级范围做出相应的调整。

Liu 等[20]认为若 2 个品种在某一数量性状表达上的差异可导致其他 1 个或多个数量性状在品种间的表达差异,主要因为这些数量性状间存在显著相关关系,这会为 DUS 测试造成一定误差。本研究的数量性状相关性分析结果中,花穗长度和花穗宽度的相关系数达到非常高水平,因此在测试过程中可考虑合并为一个性状,以减小误差,同时减少 DUS 测试的工作量;其他部分数量性状间虽有显著相关性,但相关系数较小,这说明了性状之间存在较好的相对独立性,也证明了测试指南中数量性状的选择是合理可行的。

4 结 论

数量性状是 DUS 测试指南中重要的性状之一,本研究通过最小显著差法和极差法对符合不同数据分布的 9 个数量性状进行分级研究,分级结果可作为今后荔枝 DUS 测试数量性状描述分级的依据。

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